STAT 139: Final Project

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EDA

```
set.seed(139)
library(dplyr)
# Load team data
team_data = list()
team_wins <- list()
drop = c("W", "L")
for (year in 1997:2022) {
  df1 = read.csv(paste("data/teams_data/batting", year, ".csv", sep=""))
  df2 = read.csv(paste("data/teams_data/pitching", year, ".csv", sep=""))
  df3 = read.csv(paste("data/teams_data/fielding", year, ".csv", sep=""))
  df_tot = merge(merge(df1, df2, by="Tm", suffixes=c(".bat", ".pitch")), df3, by="Tm", suffixes=c("", "

  df_tot = df_tot[
    !(df_tot$Tm %in% c("", "League Average")),
    !(names(df_tot) %in% drop)
  ]
  df_tot$Tm = factor(df_tot$Tm)
  team_data[[year]] = df_tot
  team_wins[[year]] = df_tot[, c("Tm", "W.L.")]
}

# Load player data
years <- 1997:2022
bps <- c("batting", "pitching", "fielding")
player_data <- list()
for (year in years) {
  player_data[[year]] <- list()
  for (bp in bps) {
    player_data[[year]][[bp]] <- read.csv(paste("data/player_data/", bp, year, ".csv", sep=""))
    quant_cols <- names(select_if(player_data[[year]][[bp]], is.numeric))
    for (col in quant_cols) {
      # impute data with mean
      df <- player_data[[year]][[bp]]
      player_data[[year]][[bp]][is.na(player_data[[year]][[bp]][,col]),col] <- mean(df[,col], na.rm=TRU
    }
  }
}

fa_data = list()
```

```r
for (year in years) {
  fa_data[[year]] = read.csv(paste("data/fa_data/fa", year, ".csv", sep=""))
  fa_data[[year]]$WAR3[is.na(fa_data[[year]]$WAR3)] = 0
}
```

```r
set.seed(139)
# Data Cleaning for the Team Data
team_wins <- list()
for (year in years) {
  team_wins[[year]] <- team_data[[year]][!(team_data[[year]]$Tm %in% c("", "League Average")), c("Tm", "
}
```

```r
set.seed(139)
# Clean player data
for (year in years) {
  for (bp in bps) {
    player_data[[year]][[bp]]$year <- year
    player_data[[year]][[bp]]$year_adj <- year - 1997
  }
}

for (year in years) {
  player_data[[year]][["pitching"]] = player_data[[year]][["pitching"]][!is.infinite(player_data[[year]]
}

long_team_names <- team_data[[year]][!(team_data[[year]]$Tm %in% c("", "League Average")),]$Tm
short_team_names <- c("ARI", "ATL", "BAL", "BOS", "CHC", "CHW", "CIN", "CLE", "COL", "DET",
                      "HOU", "KCR", "LAA", "LAD", "MIA", "MIL", "MIN", "NYM", "NYY", "OAK",
                      "PHI", "PIT", "SDP", "SFG", "SEA", "STL", "TBR", "TEX", "TOR", "WSN")
agg_data <- list()
for (year in years) {
  agg_data[[year]] <- list()
  for (bp in bps) {
    quant_cols <- names(select_if(player_data[[year]][[bp]], is.numeric))
    agg_data[[year]][[bp]] <- player_data[[year]][[bp]][, c("Tm", quant_cols)] %>%
      group_by(Tm) %>%
      summarise(across(quant_cols, ~weighted.mean(., w = G)))
    agg_data[[year]][[bp]] <- agg_data[[year]][[bp]][!(agg_data[[year]][[bp]]$Tm == "TOT"),]
    agg_data[[year]][[bp]]$long_Tm <- factor(
      agg_data[[year]][[bp]]$Tm,
      levels=short_team_names,
      labels=long_team_names
    )
  }
}
```

```
## Warning: Using an external vector in selections was deprecated in tidyselect 1.1.0.
## i Please use ‘all_of()‘ or ‘any_of()‘ instead.
##   # Was:
##   data %>% select(quant_cols)
##
##   # Now:
##   data %>% select(all_of(quant_cols))
```

```
##
## See <https://tidyselect.r-lib.org/reference/faq-external-vector.html>.
```

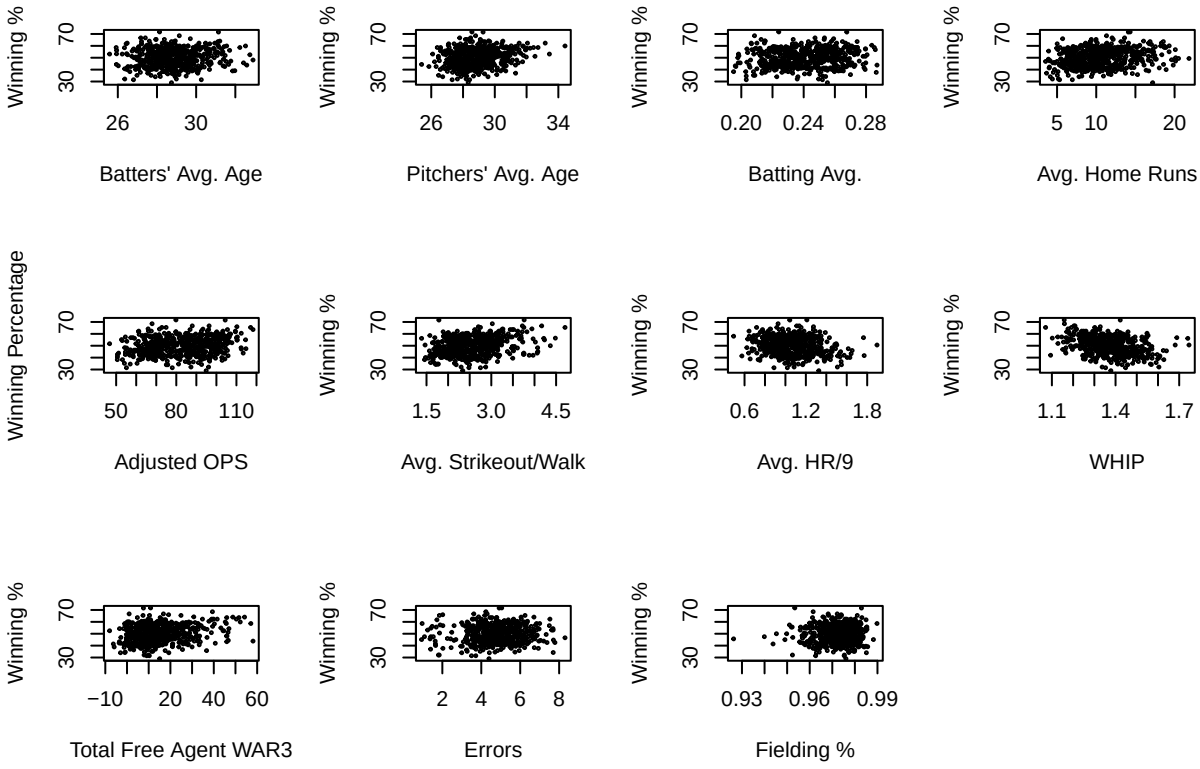
```
player_combo <- list()
for (year in years) {
  player_combo[[year]] <- merge(merge(agg_data[[year]][[bps[1]]], agg_data[[year]][[bps[2]]], by="Tm", s
}

agg_fa_data <- list()
for (year in years) {
  agg_fa_data[[year]] = fa_data[[year]] %>% group_by(To.Team) %>% summarise(tot_fa_war3=sum(WAR3), num_
}

# add response variable to player data
player_with_wins <- list()
for (year in 1997:2021) {
  player_with_wins[[year]] <- merge(player_combo[[year]], team_wins[[year+1]], by.x="long_Tm.pitch", by
}

player_with_wins_fa <- list()
for (year in 1997:2021) {
  player_with_wins_fa[[year]] <- merge(player_with_wins[[year]], agg_fa_data[[year]], by.x="long_Tm.pit
}


player_with_wins_combined = bind_rows(player_with_wins_fa, )
player_with_wins_combined$W.L..same_year = 100 * player_with_wins_combined$W.L..same_year
player_with_wins_combined$W.L..next_year = 100 * player_with_wins_combined$W.L..next_year

drop_cols = c("long_Tm.pitch", "Rk.bat", "G.bat", "long_Tm.bat", "Rk.pitch", "W", "L", "G.pitch", "long_
              "Age", "GS", "CG", "GS.field", "CG.field", "Rdrs", "Rdrs.yr", "Rgood")
player_with_wins_combined = player_with_wins_combined[, !(names(player_with_wins_combined) %in% drop_col

n.rows = nrow(player_with_wins_combined)
n.train = 0.8 * n.rows
train.rows = sample(n.rows, n.train)
train.df = player_with_wins_combined[train.rows,]
colnames(train.df)[colnames(train.df) == 'OPS.'] <- 'OPSplus'
colnames(train.df)[colnames(train.df) == 'ERA.'] <- 'ERAplus'
test.df = player_with_wins_combined[-train.rows,]
colnames(test.df)[colnames(test.df) == 'OPS.'] <- 'OPSplus'
colnames(test.df)[colnames(test.df) == 'ERA.'] <- 'ERAplus'
```

```
set.seed(139)
# train.df
names(train.df)
```

```
##  [1] "Tm"          "Age.bat"     "PA"          "AB"
##  [5] "R.bat"       "H.bat"       "X2B"         "X3B"
##  [9] "HR.bat"      "RBI"         "SB"          "CS"
## [13] "BB.bat"      "SO.bat"      "BA"          "OBP"
## [17] "SLG"         "OPS"         "OPSplus"     "TB"
## [21] "GDP"         "HBP.bat"     "SH"          "SF"
```

```
## [25] "IBB.bat"        "year.bat"       "year_adj.bat"   "Age.pitch"
## [29] "W.L..same_year" "ERA"            "GF"             "SHO"
## [33] "SV"             "IP"             "H.pitch"        "R.pitch"
## [37] "ER"             "HR.pitch"       "BB.pitch"       "IBB.pitch"
## [41] "SO.pitch"       "HBP.pitch"      "BK"             "WP"
## [45] "BF"             "ERAplus"        "FIP"            "WHIP"
## [49] "H9"             "HR9"            "BB9"            "SO9"
## [53] "SO.W"           "year.pitch"     "year_adj.pitch" "Rk"
## [57] "G"              "Inn"            "Ch"             "PO"
## [61] "A"              "E"              "DP"             "Fld."
## [65] "Rtot"           "Rtot.yr"        "RF.9"           "RF.G"
## [69] "year"           "year_adj"       "W.L..next_year" "tot_fa_war3"
## [73] "num_fas"
```

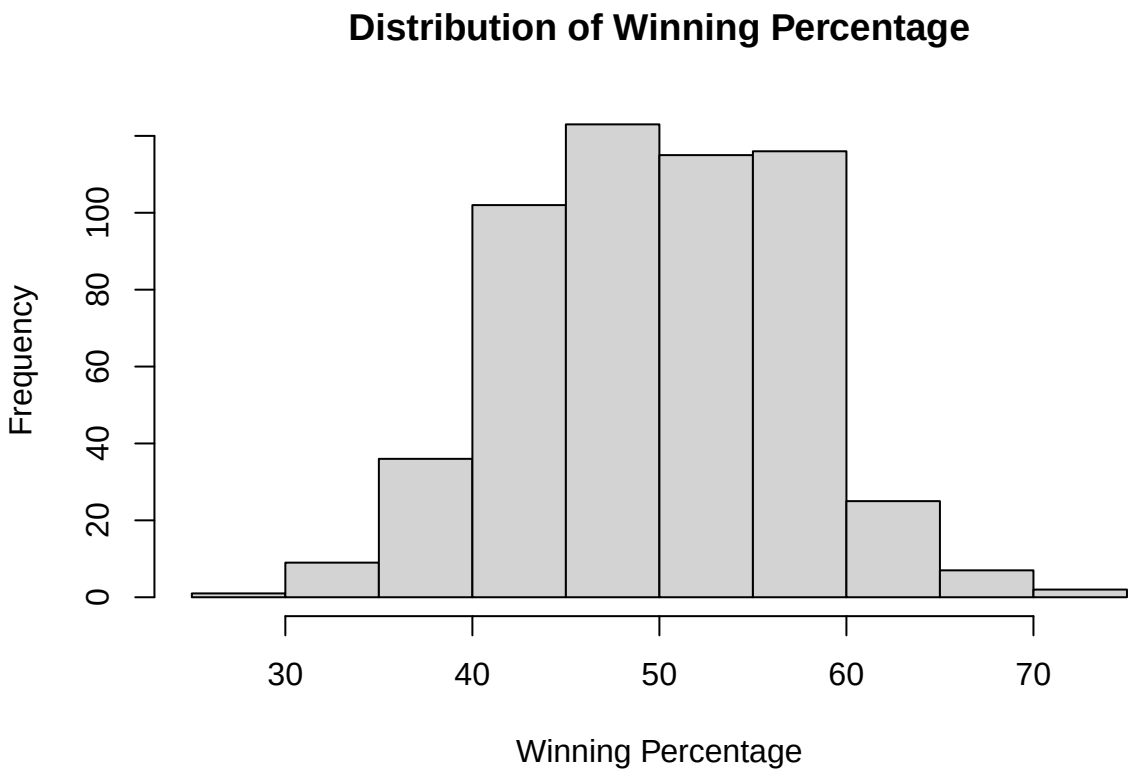
```
set.seed(139)
# Explore Potential Predictors
par(mfrow=c(3,4))
plot(W.L..next_year ~ Age.bat, data=train.df,
     xlab="Batters' Avg. Age", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ Age.pitch, data=train.df,
     xlab="Pitchers' Avg. Age", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ BA, data=train.df,
     xlab="Batting Avg.", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ HR.bat, data=train.df,
     xlab="Avg. Home Runs", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ OPSplus, data=train.df,
     xlab="Adjusted OPS", ylab="Winning Percentage", cex=0.3)
plot(W.L..next_year ~ SO.W, data=train.df,
     xlab="Avg. Strikeout/Walk", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ HR9, data=train.df,
     xlab="Avg. HR/9", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ WHIP, data=train.df,
     xlab="WHIP", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ tot_fa_war3, data=train.df,
     xlab="Total Free Agent WAR3", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ E, data=train.df,
     xlab="Errors", ylab="Winning %", cex=0.3)
plot(W.L..next_year ~ Fld., data=train.df,
     xlab="Fielding %", ylab="Winning %", cex=0.3)
```




```
set.seed(139)
# Summary statistics for winpct
summary(train.df$W.L..next_year)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   29.00   44.25   50.00   50.00   55.60   71.70
```

```
# Histogram for winpct
hist(train.df$W.L..next_year, main="Distribution of Winning Percentage",
     xlab="Winning Percentage")
```




```
set.seed(139)
# Correlation matrix
cor(train.df[, c("W.L..next_year", "Age.bat", "Age.pitch", "BA", "HR.bat", "OPS", "SO.W", "HR9", "WHIP"
```

```
##                W.L..next_year     Age.bat   Age.pitch          BA      HR.bat
## W.L..next_year     1.00000000  0.08224671  0.21742466  0.12566525  0.22847988
## Age.bat            0.08224671  1.00000000  0.55001609  0.17936468  0.14955980
## Age.pitch          0.21742466  0.55001609  1.00000000  0.11001110  0.17415837
## BA                 0.12566525  0.17936468  0.11001110  1.00000000  0.54086115
## HR.bat             0.22847988  0.14955980  0.17415837  0.54086115  1.00000000
## OPS                0.21118275  0.14622701  0.15726077  0.91088907  0.70048120
## SO.W               0.27971182 -0.12666156  0.01433416 -0.16523565  0.04242539
## HR9               -0.21914037 -0.15698253 -0.11519862  0.06053036  0.13528353
## WHIP              -0.37861475  0.01837121 -0.09029580  0.15570078 -0.02679298
## tot_fa_war3        0.24658861  0.20214373  0.27480015  0.08147753  0.12028178
## E                  0.05870997  0.07619294  0.08515064  0.15724569  0.24875661
## Fld.               0.07749318  0.11616465  0.15603131  0.03284303  0.09552827
##                           OPS        SO.W         HR9        WHIP tot_fa_war3
## W.L..next_year  0.2111827540  0.27971182 -0.21914037 -0.37861475  0.24658861
## Age.bat         0.1462270149 -0.12666156 -0.15698253  0.01837121  0.20214373
## Age.pitch       0.1572607748  0.01433416 -0.11519862 -0.09029580  0.27480015
## BA              0.9108890698 -0.16523565  0.06053036  0.15570078  0.08147753
## HR.bat          0.7004811952  0.04242539  0.13528353 -0.02679298  0.12028178
## OPS             1.0000000000 -0.03748966  0.20036799  0.10150780  0.14490028
## SO.W           -0.0374896628  1.00000000 -0.08710935 -0.74611516  0.11303284
```

```
## HR9             0.2003679869 -0.08710935  1.00000000  0.44954337 -0.01632062
## WHIP            0.1015078012 -0.74611516  0.44954337  1.00000000 -0.07786594
## tot_fa_war3     0.1449002814  0.11303284 -0.01632062 -0.07786594  1.00000000
## E               0.0483299012 -0.34676528 -0.17488952  0.19344202 -0.07855023
## Fld.            0.0001700022  0.03183827 -0.13485425 -0.15172872  0.03494714
##                           E          Fld.
## W.L..next_year  0.05870997  0.0774931799
## Age.bat         0.07619294  0.1161646523
## Age.pitch       0.08515064  0.1560313061
## BA              0.15724569  0.0328430314
## HR.bat          0.24875661  0.0955282742
## OPS             0.04832990  0.0001700022
## SO.W           -0.34676528  0.0318382734
## HR9            -0.17488952 -0.1348542488
## WHIP            0.19344202 -0.1517287249
## tot_fa_war3    -0.07855023  0.0349471418
## E               1.00000000 -0.0300911417
## Fld.           -0.03009114  1.0000000000
```

```
cor(train.df[, c("W.L..next_year", "Age.bat", "Age.pitch", "BA", "HR.bat", "OPS", "SO.W", "HR9", "WHIP"
```

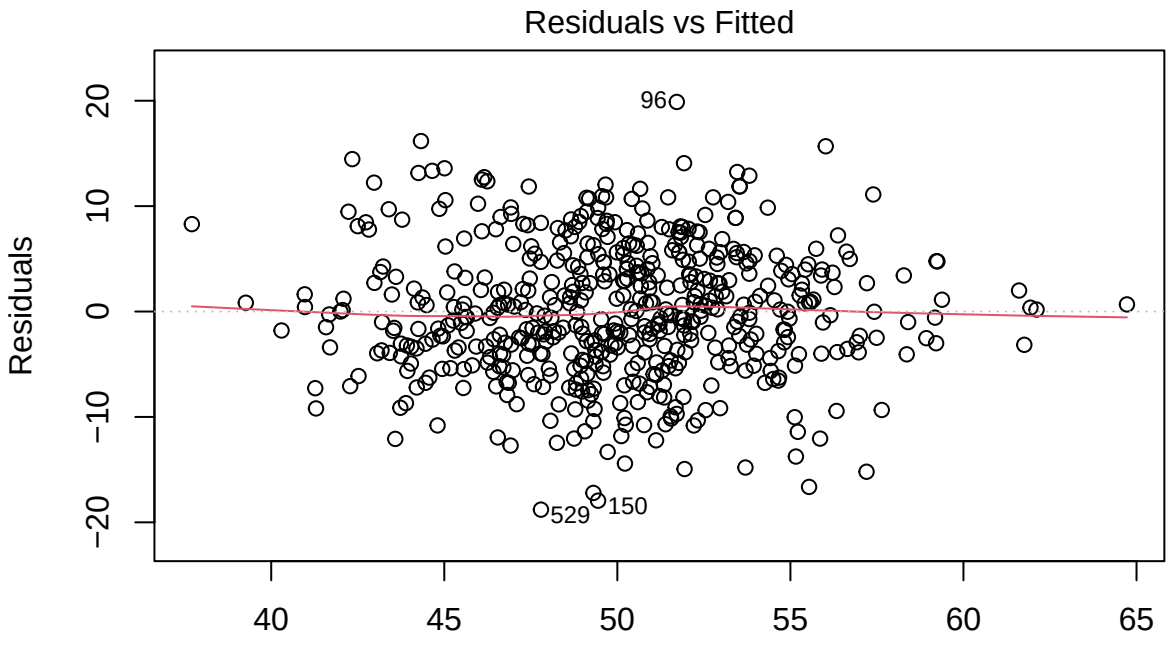
```
##                W.L..next_year      Age.bat    Age.pitch          BA
## W.L..next_year    1.000000000 0.0067645221 0.0472734818 0.015791755
## Age.bat           0.006764522 1.0000000000 0.3025177042 0.032171688
## Age.pitch         0.047273482 0.3025177042 1.0000000000 0.012102441
## BA                0.015791755 0.0321716877 0.0121024412 1.000000000
## HR.bat            0.052203057 0.0223681334 0.0303311363 0.292530787
## OPS               0.044598156 0.0213823399 0.0247309513 0.829718897
## SO.W              0.078238703 0.0160431499 0.0002054681 0.027302819
## HR9               0.048022500 0.0246435148 0.0132707225 0.003663925
## WHIP              0.143349129 0.0003375014 0.0081533311 0.024242733
## tot_fa_war3       0.060805942 0.0408620872 0.0755151242 0.006638587
## E                 0.003446860 0.0058053636 0.0072506310 0.024726208
## Fld.              0.006005193 0.0134942264 0.0243457685 0.001078665
##                      HR.bat          OPS         SO.W          HR9         WHIP
## W.L..next_year 0.0522030566 4.459816e-02 0.0782387030 0.0480224998 0.1433491285
## Age.bat        0.0223681334 2.138234e-02 0.0160431499 0.0246435148 0.0003375014
## Age.pitch      0.0303311363 2.473095e-02 0.0002054681 0.0132707225 0.0081533311
## BA             0.2925307865 8.297189e-01 0.0273028187 0.0036639247 0.0242427326
## HR.bat         1.0000000000 4.906739e-01 0.0017999134 0.0183016333 0.0007178638
## OPS            0.4906739048 1.000000e+00 0.0014054748 0.0401473302 0.0103038337
## SO.W           0.0017999134 1.405475e-03 1.0000000000 0.0075880387 0.5566878383
## HR9            0.0183016333 4.014733e-02 0.0075880387 1.0000000000 0.2020892372
## WHIP           0.0007178638 1.030383e-02 0.5566878383 0.2020892372 1.0000000000
## tot_fa_war3    0.0144677066 2.099609e-02 0.0127764222 0.0002663625 0.0060631047
## E              0.0618798534 2.335779e-03 0.1202461613 0.0305863439 0.0374198160
## Fld.           0.0091256512 2.890074e-08 0.0010136757 0.0181856684 0.0230216060
##                 tot_fa_war3           E         Fld.
## W.L..next_year 0.0608059421 0.0034468602 6.005193e-03
## Age.bat        0.0408620872 0.0058053636 1.349423e-02
## Age.pitch      0.0755151242 0.0072506310 2.434577e-02
## BA             0.0066385874 0.0247262081 1.078665e-03
## HR.bat         0.0144677066 0.0618798534 9.125651e-03
## OPS            0.0209960915 0.0023357794 2.890074e-08
```

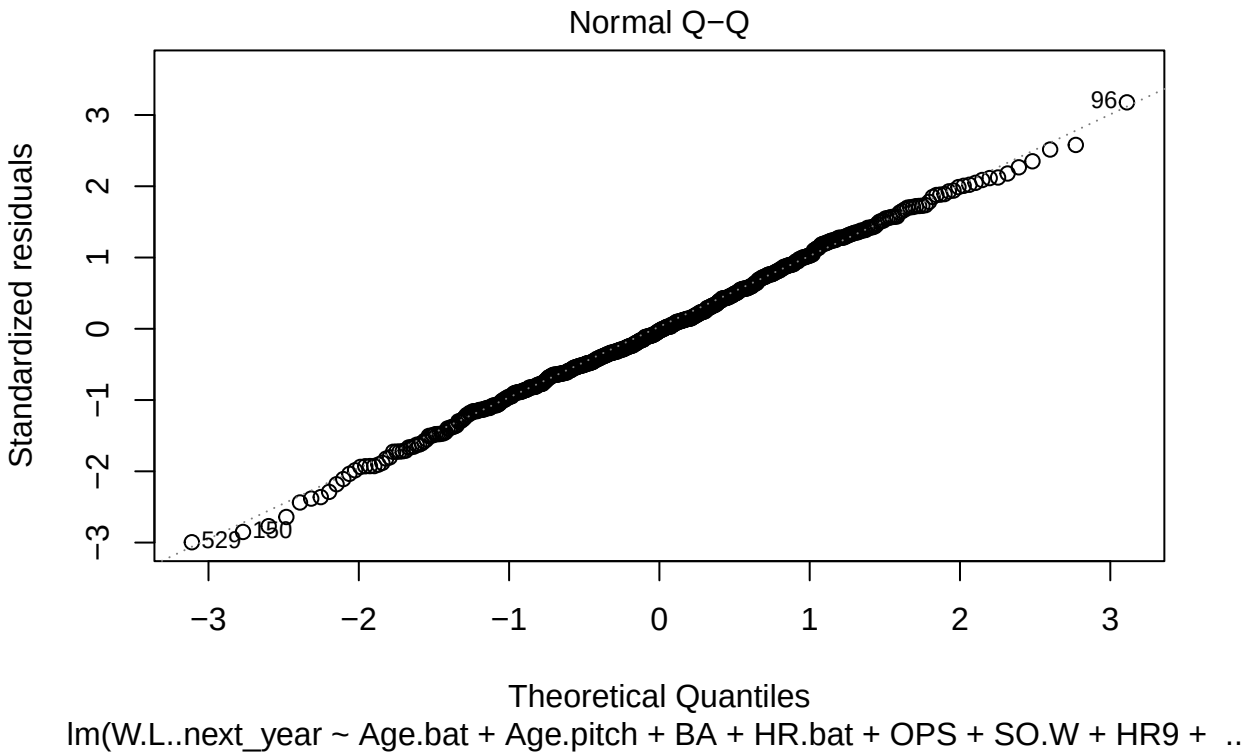
```
## SO.W           0.0127764222 0.1202461613 1.013676e-03
## HR9            0.0002663625 0.0305863439 1.818567e-02
## WHIP           0.0060631047 0.0374198160 2.302161e-02
## tot_fa_war3    1.0000000000 0.0061701382 1.221303e-03
## E              0.0061701382 1.0000000000 9.054768e-04
## Fld.           0.0012213027 0.0009054768 1.000000e+00
```

```
set.seed(139)
# Baseline Multiple Regression Model
baseline <- lm(W.L..next_year ~ Age.bat + Age.pitch + BA + HR.bat +
                 OPS + SO.W + HR9 + WHIP + tot_fa_war3 + E + Fld. , data = train.df)
summary(baseline)
```

```
##
## Call:
## lm(formula = W.L..next_year ~ Age.bat + Age.pitch + BA + HR.bat +
##     OPS + SO.W + HR9 + WHIP + tot_fa_war3 + E + Fld., data = train.df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -18.7940  -3.9996  -0.1834   4.3942  19.8820
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   28.6771    38.5617   0.744 0.457410
## Age.bat       -0.2027     0.2738  -0.740 0.459511
## Age.pitch      0.4866     0.2695   1.805 0.071580 .
## BA          -167.7755    43.1161  -3.891 0.000113 ***
## HR.bat        -0.1662     0.1318  -1.261 0.207948
## OPS           86.8924    17.1237   5.074 5.41e-07 ***
## SO.W           0.4083     0.8394   0.486 0.626876
## HR9           -5.0925     1.7943  -2.838 0.004714 **
## WHIP         -21.0898     4.8067  -4.388 1.39e-05 ***
## tot_fa_war3    0.1011     0.0249   4.061 5.63e-05 ***
## E              1.0228     0.2805   3.646 0.000293 ***
## Fld.          22.9958    37.3691   0.615 0.538577
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6.345 on 524 degrees of freedom
## Multiple R-squared:  0.2933, Adjusted R-squared:  0.2784
## F-statistic: 19.77 on 11 and 524 DF,  p-value: < 2.2e-16
```

```
set.seed(139)
# Asssess Linear Model Assumptions
plot(baseline, which=c(1,2))
```


Residuals vs Fitted
Residuals
Fitted values
lm(W.L..next_year ~ Age.bat + Age.pitch + BA + HR.bat + OPS + SO.W + HR9 + ..
96
529
150
20
10
0
−10
−20
40
45
50
55
60
65




```
set.seed(139)
RMSE <- function(y,yhat){
  SSE = sum((y-yhat)^2)
  SST = sum((y - mean(y))^2)
  return(sqrt(SSE/length(y)))
}

R2 <- function(y,yhat) {
  SSE = sum((y-yhat)^2)
  SST = sum((y-mean(y))^2)
  r.squared <- 1 - (SSE / SST)
  return(r.squared)
}
baseline.trainRMSE = RMSE(train.df$W.L..next_year, predict(baseline, newdata=train.df))
baseline.testRMSE = RMSE(test.df$W.L..next_year, predict(baseline, newdata=test.df))
baseline.trainR2 = R2(train.df$W.L..next_year, predict(baseline, newdata=train.df))
baseline.testR2 = R2(test.df$W.L..next_year, predict(baseline, newdata=test.df))
```

Linear Regression

```
set.seed(139)
colnames(train.df)
```

```
##  [1] "Tm"             "Age.bat"        "PA"             "AB"
```

```
##  [5] "R.bat"          "H.bat"          "X2B"            "X3B"
##  [9] "HR.bat"         "RBI"            "SB"             "CS"
## [13] "BB.bat"         "SO.bat"         "BA"             "OBP"
## [17] "SLG"            "OPS"            "OPSplus"        "TB"
## [21] "GDP"            "HBP.bat"        "SH"             "SF"
## [25] "IBB.bat"        "year.bat"       "year_adj.bat"   "Age.pitch"
## [29] "W.L..same_year" "ERA"            "GF"             "SHO"
## [33] "SV"             "IP"             "H.pitch"        "R.pitch"
## [37] "ER"             "HR.pitch"       "BB.pitch"       "IBB.pitch"
## [41] "SO.pitch"       "HBP.pitch"      "BK"             "WP"
## [45] "BF"             "ERAplus"        "FIP"            "WHIP"
## [49] "H9"             "HR9"            "BB9"            "SO9"
## [53] "SO.W"           "year.pitch"     "year_adj.pitch" "Rk"
## [57] "G"              "Inn"            "Ch"             "PO"
## [61] "A"              "E"              "DP"             "Fld."
## [65] "Rtot"           "Rtot.yr"        "RF.9"           "RF.G"
## [69] "year"           "year_adj"       "W.L..next_year" "tot_fa_war3"
## [73] "num_fas"
```

```
set.seed(139)
# full linear regression models

# ignore Rk.bat, R.bat, RBI, year.bat, year_adj.bat, W, L, R.pitch, year.pitch
# year_adj.pitch, Rk, WL..next_year, year, year_adj, ERA, ERAplus
# Rtot, Rtot.yr, Rdrs, Rgood (hard to interpret)
lm.full <- lm(W.L..next_year ~ Age.bat + PA + AB + H.bat + X2B + X3B +
                HR.bat + SB + CS + BB.bat + SO.bat + BA + OBP + SLG + OPS + OPSplus +
                TB + GDP + HBP.bat + SH + SF + IBB.bat + Age.pitch + W.L..same_year +
                GF + SHO + SV + IP + H.pitch + HR.pitch +
                BB.pitch + IBB.pitch + SO.pitch + HBP.pitch + BK + WP + BF +
                FIP + WHIP + H9 + HR9 + BB9 + SO9 + SO.W +
                G + Inn + Ch + PO + A + E + DP + Fld. +
                RF.9 + RF.G + tot_fa_war3 + num_fas,
              data = train.df)
lmfull.trainRMSE = RMSE(train.df$W.L..next_year, predict(lm.full, newdata=train.df))
```

```
## Warning in predict.lm(lm.full, newdata = train.df): prediction from a rank-
## deficient fit may be misleading
```

```
lmfull.testRMSE = RMSE(test.df$W.L..next_year, predict(lm.full, newdata=test.df))
```

```
## Warning in predict.lm(lm.full, newdata = test.df): prediction from a rank-
## deficient fit may be misleading
```

```
lmfull.trainR2 = R2(train.df$W.L..next_year, predict(lm.full, newdata=train.df))
```

```
## Warning in predict.lm(lm.full, newdata = train.df): prediction from a rank-
## deficient fit may be misleading
```

```
lmfull.testR2 = R2(test.df$W.L..next_year, predict(lm.full, newdata=test.df))
```

```
## Warning in predict.lm(lm.full, newdata = test.df): prediction from a rank-
## deficient fit may be misleading
```

```
lm.fullinteraction <- lm(W.L..next_year ~ (Age.bat + PA + AB + H.bat + X2B + X3B +
                HR.bat + SB + CS + BB.bat + SO.bat + BA + OBP + SLG + OPS + OPSplus +
                TB + GDP + HBP.bat + SH + SF + IBB.bat + Age.pitch + W.L..same_year +
                GF + SHO + SV + IP + H.pitch + HR.pitch +
                BB.pitch + IBB.pitch + SO.pitch + HBP.pitch + BK + WP + BF +
                FIP + WHIP + H9 + HR9 + BB9 + SO9 + SO.W +
                G + Inn + Ch + PO + A + E + DP + Fld. +
                RF.9 + RF.G + tot_fa_war3 + num_fas)^2, data = train.df)
lmfullinteraction.trainRMSE = RMSE(train.df$W.L..next_year, predict(lm.fullinteraction, newdata=train.d
```

```
## Warning in predict.lm(lm.fullinteraction, newdata = train.df): prediction from a
## rank-deficient fit may be misleading
```

```
lmfullinteraction.testRMSE = RMSE(test.df$W.L..next_year, predict(lm.fullinteraction, newdata=test.df))
```

```
## Warning in predict.lm(lm.fullinteraction, newdata = test.df): prediction from a
## rank-deficient fit may be misleading
```

```
lmfullinteraction.trainR2 = R2(train.df$W.L..next_year, predict(lm.fullinteraction, newdata=train.df))
```

```
## Warning in predict.lm(lm.fullinteraction, newdata = train.df): prediction from a
## rank-deficient fit may be misleading
```

```
lmfullinteraction.testR2 = R2(test.df$W.L..next_year, predict(lm.fullinteraction, newdata=test.df))
```

```
## Warning in predict.lm(lm.fullinteraction, newdata = test.df): prediction from a
## rank-deficient fit may be misleading
```

```
set.seed(139)
# Ridge Regression

library(glmnet)
library(caret)
# regularize full model
X.full = model.matrix(lm.full)[,-1] # drop intercept
best_lambda = cv.glmnet(X.full, train.df$W.L..next_year, alpha=0, lambda=10^seq(-4, 4, 0.1))$lambda.min
```

```
## [1] 1.258925
```

```
ridges.full = glmnet(X.full, train.df$W.L..next_year, alpha=0,
                     lambda=best_lambda)
imp <- as.data.frame(varImp(ridges.full, lambda=best_lambda))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##         overall          names
## 13 38.477736084            OBP
## 52 18.456583694           Fld.
## 14 15.601157020            SLG
## 15 10.724432677            OPS
## 39  6.301111400           WHIP
## 26  4.141528257            SHO
## 54  2.620403240           RF.G
## 35  2.396357966             BK
## 41  1.381743878            HR9
## 40  1.274423913             H9
## 6   1.085219884            X3B
## 53  0.914094505           RF.9
## 12  0.886964726             BA
## 44  0.712124475           SO.W
## 50  0.673709784              E
## 1   0.586007374        Age.bat
## 21  0.549970024             SF
## 27  0.521312683             SV
## 38  0.494165501            FIP
## 18  0.320275512            GDP
## 23  0.290692207      Age.pitch
## 22  0.274295723        IBB.bat
## 36  0.243314144             WP
## 19  0.191332625        HBP.bat
## 7   0.175062409         HR.bat
## 56  0.163850160        num_fas
## 34  0.133383866      HBP.pitch
## 9   0.131622360             CS
## 42  0.120136439            BB9
## 10  0.116747513         BB.bat
## 20  0.107565830             SH
## 30  0.105921024       HR.pitch
## 55  0.101320836    tot_fa_war3
## 51  0.067550922             DP
## 32  0.056254183      IBB.pitch
## 8   0.050791255             SB
## 11  0.044892607         SO.bat
## 24  0.044641504 W.L..same_year
## 5   0.037831904            X2B
## 45  0.032913264              G
## 31  0.028445257       BB.pitch
## 25  0.026984609             GF
## 29  0.023033420        H.pitch
## 33  0.016628685       SO.pitch
## 16  0.012891287        OPSplus
## 49  0.008648619              A
## 3   0.007430170             AB
## 43  0.006174093            SO9
## 17  0.005546618             TB
## 2   0.004742543             PA
## 46  0.004618640            Inn
## 28  0.002391996             IP
## 47  0.002098550             Ch
```

```
## 48  0.001697397             PO
## 4   0.001594227          H.bat
## 37  0.001291232             BF
```

```
X.full.test = model.matrix(lm.full, data=test.df)[,-1] # drop intercept

yhats.full.train = predict(ridges.full, X.full)
ridgesfull.trainRMSE = RMSE(train.df$W.L..next_year, yhats.full.train) # train RMSE
ridgesfull.trainR2 = R2(train.df$W.L..next_year, yhats.full.train) # train R2

yhats.full.test = predict(ridges.full, X.full.test)
#plot(RMSE.ridges.full.test~log(ridges.full$lambda, 10), type='l')
ridgesfull.testRMSE = RMSE(test.df$W.L..next_year, yhats.full.test) # test RMSE
ridgesfull.testR2 = R2(test.df$W.L..next_year, yhats.full.test) # test R2
```

```
set.seed(139)
# regularize full interaction model
X.fullinteraction = model.matrix(lm.fullinteraction)[,-1] # drop intercept

best_lambda = cv.glmnet(X.fullinteraction, train.df$W.L..next_year, alpha=0,
                        lambda=10^seq(-4, 4, 0.1))$lambda.min; best_lambda
```

```
## [1] 19.95262
```

```
ridges.fullinteraction = glmnet(X.fullinteraction, train.df$W.L..next_year, alpha=0,
                      lambda=best_lambda)
imp <- as.data.frame(varImp(ridges.fullinteraction, lambda=best_lambda))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##           overall                    names
## 52   6.385091e+00                     Fld.
## 607  4.054872e+00                   BA:OBP
## 689  3.740522e+00                  OBP:Fld.
## 651  3.061896e+00                  OBP:SLG
## 13   2.611850e+00                      OBP
## 608  2.189910e+00                   BA:SLG
## 652  1.919731e+00                  OBP:OPS
## 646  1.681135e+00                   BA:Fld.
## 731  1.495566e+00                  SLG:Fld.
## 609  1.373677e+00                   BA:OPS
## 694  1.034693e+00                  SLG:OPS
## 14   9.913106e-01                      SLG
## 772  9.911531e-01                  OPS:Fld.
## 15   6.955925e-01                      OPS
## 39   6.902952e-01                     WHIP
## 690  6.683200e-01                  OBP:RF.9
## 1456 6.291626e-01                 WHIP:Fld.
## 663  5.484006e-01                  OBP:SHO
## 633  4.971271e-01                   BA:WHIP
## 620  4.731580e-01                   BA:SHO
```

```
## 705  4.183714e-01                SLG:SHO
## 12   3.467440e-01                     BA
## 647  3.467187e-01                 BA:RF.9
## 732  3.358569e-01                SLG:RF.9
## 691  3.051668e-01                OBP:RF.G
## 629  2.530676e-01                   BA:BK
## 54   2.345447e-01                    RF.G
## 1588 2.286201e-01               Fld.:RF.G
## 681  2.279420e-01                OBP:SO.W
## 936  2.012303e-01                  SH:SHO
## 773  2.002136e-01                OPS:RF.9
## 746  1.925796e-01                 OPS:SHO
## 635  1.904059e-01                  BA:HR9
## 638  1.875550e-01                 BA:SO.W
## 723  1.739045e-01                SLG:SO.W
## 1458 1.546932e-01               WHIP:RF.G
## 644  1.511051e-01                     BA:E
## 687  1.506929e-01                    OBP:E
## 733  1.457361e-01                SLG:RF.G
## 676  1.379635e-01                OBP:WHIP
## 675  1.338318e-01                 OBP:FIP
## 26   1.327488e-01                     SHO
## 679  1.302018e-01                 OBP:BB9
## 664  1.258092e-01                  OBP:SV
## 40   1.249365e-01                      H9
## 1137 1.242149e-01            SHO:IBB.pitch
## 1472 1.227993e-01                 H9:Fld.
## 1005 1.185078e-01              IBB.bat:SHO
## 621  1.164534e-01                    BA:SV
## 671  1.075054e-01            OBP:HBP.pitch
## 729  1.033303e-01                     SLG:E
## 1445 9.745561e-02                WHIP:HR9
## 634  9.736223e-02                   BA:H9
## 764  9.632404e-02                OPS:SO.W
## 41   9.577529e-02                     HR9
## 657  9.498878e-02                  OBP:SH
## 660  9.441026e-02            OBP:Age.pitch
## 35   9.185567e-02                      BK
## 1487 8.768191e-02                HR9:Fld.
## 706  8.693601e-02                  SLG:SV
## 614  8.588340e-02                   BA:SH
## 1369 8.264228e-02                 BK:WHIP
## 1140 8.233723e-02                  SHO:BK
## 659  8.108636e-02               OBP:IBB.bat
## 680  7.863949e-02                  OBP:SO9
## 327  7.341413e-02                  X3B:BA
## 1457 7.324305e-02               WHIP:RF.9
## 1299 7.300752e-02             IBB.pitch:BK
## 1371 7.262146e-02                 BK:HR9
## 628  6.991909e-02             BA:HBP.pitch
## 1    6.979236e-02                  Age.bat
## 1157 6.870984e-02                SHO:Fld.
## 616  6.847094e-02               BA:IBB.bat
## 717  6.749071e-02                  SLG:FIP
```

```
## 774  6.689612e-02                OPS:RF.G
## 699  6.595221e-02                  SLG:SH
## 1526 6.459251e-02               SO.W:Fld.
## 713  6.355854e-02            SLG:HBP.pitch
## 1155 5.864362e-02                   SHO:E
## 107  5.778017e-02             Age.bat:Fld.
## 341  5.692076e-02                 X3B:SHO
## 714  5.654714e-02                  SLG:BK
## 38   5.652606e-02                     FIP
## 1489 5.624349e-02               HR9:RF.G
## 701  5.540271e-02             SLG:IBB.bat
## 617  5.476538e-02             BA:Age.pitch
## 770  5.466814e-02                   OPS:E
## 67   5.417273e-02               Age.bat:BA
## 721  5.375004e-02                  SLG:BB9
## 44   5.371606e-02                     SO.W
## 1144 5.147008e-02                 SHO:WHIP
## 1587 5.100959e-02               Fld.:RF.9
## 986  4.815573e-02                   SF:HR9
## 747  4.700568e-02                   OPS:SV
## 755  4.684949e-02                   OPS:BK
## 1147 4.675968e-02                 SHO:BB9
## 1382 4.575951e-02                  BK:Fld.
## 702  4.535625e-02            SLG:Age.pitch
## 662  4.487567e-02                   OBP:GF
## 6    4.459078e-02                      X3B
## 42   4.385952e-02                      BB9
## 900  4.295843e-02             HBP.bat:SHO
## 1447 4.256665e-02                WHIP:SO9
## 656  4.242944e-02             OBP:HBP.bat
## 722  4.240518e-02                  SLG:SO9
## 1344 4.153462e-02             HBP.pitch:BK
## 485  4.045658e-02                   CS:SHO
## 1446 3.933492e-02                WHIP:BB9
## 1014 3.921717e-02              IBB.bat:BK
## 1501 3.803999e-02                BB9:Fld.
## 673  3.788208e-02                   OBP:WP
## 669  3.787595e-02            OBP:IBB.pitch
## 1366 3.743856e-02                    BK:WP
## 494  3.709321e-02                    CS:BK
## 658  3.694529e-02                   OBP:SF
## 667  3.623507e-02             OBP:HR.pitch
## 329  3.587710e-02                  X3B:SLG
## 758  3.508114e-02                  OPS:FIP
## 1444 3.490083e-02                  WHIP:H9
## 740  3.489439e-02                   OPS:SH
## 53   3.487197e-02                     RF.9
## 1064 3.466182e-02           Age.pitch:Fld.
## 915  3.461448e-02              HBP.bat:HR9
## 1439 3.436650e-02                 FIP:Fld.
## 1384 3.434246e-02                  BK:RF.G
## 1426 3.376840e-02                 FIP:WHIP
## 328  3.335181e-02                  X3B:OBP
## 619  3.301769e-02                    BA:GF
```

```
## 971  3.231677e-02                SF:SHO
## 1477 3.225655e-02               HR9:BB9
## 754  3.200379e-02          OPS:HBP.pitch
## 945  3.145751e-02                SH:BK
## 1372 3.072757e-02                BK:BB9
## 762  3.062808e-02               OPS:BB9
## 23   3.061734e-02            Age.pitch
## 447  3.027876e-02                SB:BK
## 743  2.876138e-02          OPS:Age.pitch
## 704  2.871781e-02                SLG:GF
## 94   2.851926e-02           Age.bat:WHIP
## 759  2.848827e-02               OPS:WHIP
## 742  2.801887e-02           OPS:IBB.bat
## 1474 2.756679e-02               H9:RF.G
## 50   2.744017e-02                     E
## 377  2.641697e-02           HR.bat:OBP
## 27   2.633337e-02                    SV
## 763  2.588536e-02               OPS:SO9
## 984  2.587865e-02               SF:WHIP
## 1149 2.578273e-02               SHO:SO.W
## 1380 2.573754e-02                   BK:E
## 1158 2.542795e-02               SHO:RF.9
## 872  2.520921e-02                 GDP:BK
## 367  2.520311e-02               X3B:Fld.
## 1503 2.479398e-02               BB9:RF.G
## 624  2.473684e-02            BA:HR.pitch
## 711  2.447745e-02          SLG:IBB.pitch
## 1577 2.355173e-02                E:Fld.
## 1591 2.354789e-02              RF.9:RF.G
## 354  2.243710e-02               X3B:WHIP
## 1143 2.238389e-02                 SHO:FIP
## 376  2.186923e-02              HR.bat:BA
## 1479 2.158760e-02               HR9:SO.W
## 913  2.154978e-02           HBP.bat:WHIP
## 1305 2.125860e-02          IBB.pitch:HR9
## 349  2.100219e-02          X3B:HBP.pitch
## 9    2.073909e-02                    CS
## 648  2.069290e-02                BA:RF.G
## 997  2.062341e-02                SF:Fld.
## 1441 2.039511e-02               FIP:RF.G
## 330  1.944029e-02                X3B:OPS
## 472  1.933899e-02                 CS:OBP
## 1493 1.907409e-02               BB9:SO.W
## 1159 1.905205e-02               SHO:RF.G
## 650  1.901006e-02            BA:num_fas
## 709  1.894732e-02           SLG:HR.pitch
## 1169 1.869833e-02                 SV:BK
## 878  1.859409e-02               GDP:HR9
## 1383 1.846955e-02                BK:RF.9
## 517  1.806965e-02             BB.bat:BA
## 518  1.798434e-02             BB.bat:OBP
## 1373 1.797791e-02                 BK:SO9
## 698  1.796887e-02            SLG:HBP.bat
## 954  1.767609e-02                SH:SO.W
```

```
## 500  1.760784e-02                  CS:HR9
## 1428 1.733959e-02                 FIP:HR9
## 425  1.720622e-02                  SB:OBP
## 661  1.713631e-02        OBP:W.L..same_year
## 1361 1.693726e-02            HBP.pitch:Fld.
## 626  1.668612e-02              BA:IBB.pitch
## 21   1.627102e-02                      SF
## 359  1.563565e-02                X3B:SO.W
## 390  1.560058e-02              HR.bat:SHO
## 1473 1.556356e-02                 H9:RF.9
## 36   1.555233e-02                      WP
## 1186 1.551048e-02                 SV:Fld.
## 1461 1.550791e-02                  H9:HR9
## 1303 1.540449e-02           IBB.pitch:WHIP
## 745  1.513303e-02                  OPS:GF
## 1488 1.502061e-02                HR9:RF.9
## 1101 1.478577e-02                  GF:SHO
## 1146 1.416745e-02                 SHO:HR9
## 378  1.393561e-02              HR.bat:SLG
## 1448 1.391779e-02               WHIP:SO.W
## 760  1.384597e-02                  OPS:H9
## 909  1.356390e-02              HBP.bat:BK
## 438  1.307776e-02                  SB:SHO
## 678  1.302621e-02                 OBP:HR9
## 424  1.300590e-02                   SB:BA
## 1514 1.294659e-02                SO9:Fld.
## 649  1.275417e-02           BA:tot_fa_war3
## 1527 1.270561e-02                SO.W:RF.9
## 416  1.266619e-02              HR.bat:Fld.
## 1051 1.248471e-02           Age.pitch:WHIP
## 1370 1.246242e-02                   BK:H9
## 1386 1.244147e-02              BK:num_fas
## 613  1.242802e-02              BA:HBP.bat
## 278  1.242372e-02                 X2B:OBP
## 719  1.234049e-02                  SLG:H9
## 1485 1.229252e-02                   HR9:E
## 32   1.228595e-02               IBB.pitch
## 1353 1.227802e-02           HBP.pitch:SO.W
## 1524 1.227487e-02                   SO.W:E
## 18   1.223487e-02                      GDP
## 1368 1.213099e-02                  BK:FIP
## 1023 1.197654e-02             IBB.bat:SO.W
## 682  1.190701e-02                   OBP:G
## 692  1.189775e-02          OBP:tot_fa_war3
## 498  1.183339e-02                  CS:WHIP
## 1141 1.180322e-02                  SHO:WP
## 519  1.172777e-02              BB.bat:SLG
## 876  1.162844e-02                GDP:WHIP
## 668  1.128719e-02             OBP:BB.pitch
## 618  1.125755e-02         BA:W.L..same_year
## 1454 1.101160e-02                   WHIP:E
## 889  1.095158e-02                GDP:Fld.
## 1385 1.093069e-02           BK:tot_fa_war3
## 109  1.078054e-02             Age.bat:RF.G
```

```
## 1516 1.062361e-02                 SO9:RF.G
## 426  1.049622e-02                   SB:SLG
## 336  1.019962e-02                   X3B:SF
## 615  1.007995e-02                    BA:SF
## 655  1.006165e-02                  OBP:GDP
## 739  9.981552e-03               OPS:HBP.bat
## 369  9.932339e-03                  X3B:RF.G
## 752  9.930839e-03             OPS:IBB.pitch
## 932  9.867685e-03                SH:IBB.bat
## 703  9.789216e-03        SLG:W.L..same_year
## 639  9.365581e-03                     BA:G
## 612  9.312527e-03                  BA:GDP
## 750  9.267934e-03              OPS:HR.pitch
## 630  9.214056e-03                    BA:WP
## 672  9.118431e-03                  OBP:BK
## 379  9.113676e-03               HR.bat:OPS
## 350  9.074141e-03                  X3B:BK
## 688  8.707103e-03                  OBP:DP
## 1135 8.617281e-03              SHO:HR.pitch
## 670  8.585895e-03              OBP:SO.pitch
## 1463 8.536659e-03                   H9:SO9
## 1316 8.531344e-03            IBB.pitch:Fld.
## 693  8.524893e-03               OBP:num_fas
## 1350 8.512421e-03             HBP.pitch:HR9
## 1462 8.436899e-03                   H9:BB9
## 1176 8.429513e-03                   SV:BB9
## 1256 8.421836e-03              HR.pitch:HR9
## 983  8.381181e-03                   SF:FIP
## 22   8.371900e-03                  IBB.bat
## 734  8.340134e-03           SLG:tot_fa_war3
## 1132 8.290223e-03                   SHO:SV
## 337  8.186874e-03              X3B:IBB.bat
## 980  8.143119e-03                    SF:BK
## 96   7.836274e-03               Age.bat:HR9
## 918  7.810477e-03              HBP.bat:SO.W
## 720  7.743345e-03                   SLG:HR9
## 761  7.688109e-03                   OPS:HR9
## 7    7.684597e-03                    HR.bat
## 1374 7.680224e-03                   BK:SO.W
## 1156 7.665854e-03                   SHO:DP
## 632  7.638628e-03                   BA:FIP
## 317  7.604632e-03                  X2B:Fld.
## 1254 7.553931e-03             HR.pitch:WHIP
## 735  7.478667e-03               SLG:num_fas
## 557  7.411496e-03               BB.bat:Fld.
## 637  7.337478e-03                   BA:SO9
## 277  7.298326e-03                   X2B:BA
## 724  7.277382e-03                    SLG:G
## 665  7.253586e-03                   OBP:IP
## 977  7.203147e-03              SF:IBB.pitch
## 636  7.112889e-03                   BA:BB9
## 368  7.091666e-03                  X3B:RF.9
## 1031 7.071413e-03              IBB.bat:Fld.
## 520  6.967511e-03                BB.bat:OPS
```

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## 1160 6.893936e-03            SHO:tot_fa_war3
## 1478 6.889186e-03                    HR9:SO9
## 1175 6.845875e-03                     SV:HR9
## 677  6.808001e-03                     OBP:H9
## 999  6.757583e-03                    SF:RF.G
## 700  6.753500e-03                     SLG:SF
## 1429 6.631441e-03                    FIP:BB9
## 427  6.521479e-03                     SB:OPS
## 949  6.514532e-03                    SH:WHIP
## 1431 6.505531e-03                   FIP:SO.W
## 1110 6.457356e-03                      GF:BK
## 912  6.445949e-03                HBP.bat:FIP
## 1298 6.430868e-03        IBB.pitch:HBP.pitch
## 1389 6.409986e-03                   WP:WHIP
## 715  6.368679e-03                     SLG:WP
## 20   6.313672e-03                         SH
## 1430 6.293028e-03                    FIP:SO9
## 1020 6.250011e-03                IBB.bat:HR9
## 1427 6.118837e-03                     FIP:H9
## 1300 6.100003e-03                IBB.pitch:WP
## 69   6.057088e-03                Age.bat:SLG
## 931  6.048005e-03                      SH:SF
## 981  6.023284e-03                      SF:WP
## 1460 5.999175e-03               WHIP:num_fas
## 916  5.955641e-03                HBP.bat:BB9
## 686  5.947901e-03                      OBP:A
## 503  5.907674e-03                     CS:SO.W
## 962  5.906341e-03                     SH:Fld.
## 987  5.892171e-03                     SF:BB9
## 942  5.848186e-03               SH:IBB.pitch
## 1275 5.821293e-03                BB.pitch:BK
## 979  5.774629e-03               SF:HBP.pitch
## 627  5.735329e-03                BA:SO.pitch
## 408  5.697223e-03                HR.bat:SO.W
## 744  5.675790e-03         OPS:W.L..same_year
## 1512 5.669764e-03                      SO9:E
## 1502 5.646401e-03                   BB9:RF.9
## 625  5.636765e-03                BA:BB.pitch
## 1506 5.620862e-03                   SO9:SO.W
## 1173 5.600552e-03                     SV:WHIP
## 1437 5.520498e-03                      FIP:E
## 937  5.447762e-03                      SH:SV
## 1499 5.406639e-03                      BB9:E
## 622  5.401262e-03                      BA:IP
## 967  5.378958e-03                 SF:IBB.bat
## 895  5.304266e-03                 HBP.bat:SF
## 279  5.234195e-03                    X2B:SLG
## 1362 5.183501e-03              HBP.pitch:RF.9
## 1114 5.083248e-03                     GF:WHIP
## 1491 5.067298e-03                HR9:num_fas
## 493  5.036428e-03               CS:HBP.pitch
## 90   5.036191e-03                  Age.bat:BK
## 95   4.954489e-03                  Age.bat:H9
## 1302 4.848953e-03               IBB.pitch:FIP
```

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## 1348 4.828068e-03             HBP.pitch:WHIP
## 358  4.826251e-03                    X3B:SO9
## 10   4.825883e-03                     BB.bat
## 908  4.804756e-03           HBP.bat:HBP.pitch
## 710  4.798038e-03                SLG:BB.pitch
## 1038 4.775627e-03               Age.pitch:SHO
## 730  4.773098e-03                     SLG:DP
## 1096 4.771284e-03         W.L..same_year:Fld.
## 643  4.733367e-03                      BA:A
## 24   4.721277e-03              W.L..same_year
## 775  4.663643e-03             OPS:tot_fa_war3
## 940  4.622041e-03                 SH:HR.pitch
## 453  4.574704e-03                     SB:HR9
## 1400 4.566065e-03                       WP:E
## 707  4.541278e-03                     SLG:IP
## 985  4.528473e-03                      SF:H9
## 1011 4.524798e-03           IBB.bat:IBB.pitch
## 776  4.524691e-03                 OPS:num_fas
## 56   4.523294e-03                     num_fas
## 1492 4.516451e-03                     BB9:SO9
## 1170 4.514105e-03                       SV:WP
## 953  4.508105e-03                      SH:SO9
## 1187 4.507247e-03                     SV:RF.9
## 1172 4.500352e-03                      SV:FIP
## 1116 4.494475e-03                      GF:HR9
## 491  4.477789e-03                CS:IBB.pitch
## 1267 4.473373e-03               HR.pitch:Fld.
## 1590 4.471470e-03                Fld.:num_fas
## 403  4.391864e-03                 HR.bat:WHIP
## 712  4.353933e-03                SLG:SO.pitch
## 70   4.346979e-03                 Age.bat:OPS
## 1589 4.319524e-03            Fld.:tot_fa_war3
## 1306 4.302272e-03              IBB.pitch:BB9
## 1136 4.261146e-03                SHO:BB.pitch
## 653  4.249282e-03                OBP:OPSplus
## 356  4.226286e-03                     X3B:HR9
## 1250 4.181281e-03                 HR.pitch:BK
## 55   4.163745e-03                 tot_fa_war3
## 108  4.150617e-03                Age.bat:RF.9
## 728  4.130225e-03                       SLG:A
## 964  4.110508e-03                     SH:RF.G
## 355  4.104382e-03                      X3B:H9
## 347  4.083813e-03              X3B:IBB.pitch
## 93   4.071338e-03                 Age.bat:FIP
## 1578 4.064073e-03                      E:RF.9
## 718  4.029859e-03                   SLG:WHIP
## 1359 4.010370e-03                 HBP.pitch:E
## 357  4.001578e-03                     X3B:BB9
## 396  3.989435e-03            HR.bat:IBB.pitch
## 765  3.946561e-03                       OPS:G
## 1178 3.933641e-03                     SV:SO.W
## 1018 3.933405e-03                 IBB.bat:WHIP
## 1582 3.932507e-03                      DP:Fld.
## 562  3.910744e-03                   SO.bat:BA
```

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## 906  3.869734e-03          HBP.bat:IBB.pitch
## 1015 3.854634e-03                 IBB.bat:WP
## 280  3.812020e-03                    X2B:OPS
## 910  3.784823e-03                 HBP.bat:WP
## 1345 3.780734e-03               HBP.pitch:WP
## 891  3.745819e-03                   GDP:RF.G
## 540  3.694835e-03                  BB.bat:BK
## 1065 3.674303e-03             Age.pitch:RF.9
## 353  3.635380e-03                    X3B:FIP
## 914  3.633139e-03                 HBP.bat:H9
## 5    3.609162e-03                        X2B
## 544  3.584382e-03                BB.bat:WHIP
## 1148 3.570688e-03                    SHO:SO9
## 1308 3.558867e-03             IBB.pitch:SO.W
## 989  3.558063e-03                    SF:SO.W
## 43   3.555438e-03                        SO9
## 444  3.536673e-03              SB:IBB.pitch
## 291  3.498641e-03                    X2B:SHO
## 333  3.491812e-03                    X3B:GDP
## 875  3.488273e-03                    GDP:FIP
## 486  3.475219e-03                      CS:SV
## 479  3.443890e-03                      CS:SH
## 901  3.439952e-03                 HBP.bat:SV
## 998  3.389738e-03                    SF:RF.9
## 741  3.320844e-03                     OPS:SF
## 1402 3.313182e-03                    WP:Fld.
## 1464 3.248770e-03                    H9:SO.W
## 417  3.208204e-03                 HR.bat:RF.9
## 1281 3.165260e-03                 BB.pitch:HR9
## 309  3.142850e-03                    X2B:SO.W
## 858  3.128910e-03                      GDP:SF
## 334  3.118363e-03                X3B:HBP.bat
## 869  3.107162e-03              GDP:IBB.pitch
## 697  3.050746e-03                    SLG:GDP
## 654  3.018055e-03                     OBP:TB
## 474  2.999623e-03                     CS:OPS
## 418  2.948040e-03                 HR.bat:RF.G
## 1145 2.941083e-03                     SHO:H9
## 1188 2.939798e-03                    SV:RF.G
## 1486 2.923472e-03                     HR9:DP
## 513  2.894631e-03                    CS:RF.G
## 1066 2.835116e-03             Age.pitch:RF.G
## 666  2.831158e-03                OBP:H.pitch
## 928  2.807396e-03                HBP.bat:RF.G
## 1241 2.767916e-03                H.pitch:Fld.
## 97   2.756755e-03                Age.bat:BB9
## 51   2.756680e-03                         DP
## 464  2.756659e-03                    SB:Fld.
## 1394 2.747944e-03                    WP:SO.W
## 300  2.740140e-03                     X2B:BK
## 546  2.729483e-03                  BB.bat:HR9
## 1490 2.717220e-03           HR9:tot_fa_war3
## 1404 2.716007e-03                    WP:RF.G
## 1032 2.709432e-03                IBB.bat:RF.9
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## 1047 2.682953e-03              Age.pitch:BK
## 8    2.648061e-03                        SB
## 439  2.638060e-03                     SB:SV
## 1127 2.636792e-03                   GF:Fld.
## 497  2.636237e-03                     CS:FIP
## 1304 2.593711e-03                IBB.pitch:H9
## 695  2.573284e-03                 SLG:OPSplus
## 509  2.556492e-03                        CS:E
## 988  2.548045e-03                     SF:SO9
## 1381 2.543389e-03                      BK:DP
## 1053 2.529556e-03              Age.pitch:HR9
## 1505 2.529230e-03                BB9:num_fas
## 1079 2.488404e-03          W.L..same_year:BK
## 1006 2.483915e-03                 IBB.bat:SV
## 975  2.463877e-03               SF:HR.pitch
## 511  2.459121e-03                   CS:Fld.
## 61   2.446675e-03                Age.bat:X3B
## 481  2.442302e-03                 CS:IBB.bat
## 1184 2.440213e-03                       SV:E
## 406  2.423373e-03                 HR.bat:BB9
## 1318 2.413521e-03             IBB.pitch:RF.G
## 751  2.390827e-03               OPS:BB.pitch
## 1279 2.387585e-03              BB.pitch:WHIP
## 81   2.371942e-03                Age.bat:SHO
## 753  2.371440e-03               OPS:SO.pitch
## 645  2.370870e-03                      BA:DP
## 1052 2.351693e-03              Age.pitch:H9
## 1459 2.330842e-03           WHIP:tot_fa_war3
## 748  2.321985e-03                     OPS:IP
## 611  2.282199e-03                      BA:TB
## 1579 2.276726e-03                     E:RF.G
## 515  2.265000e-03                CS:num_fas
## 879  2.221246e-03                   GDP:BB9
## 499  2.212376e-03                     CS:H9
## 904  2.195979e-03           HBP.bat:HR.pitch
## 924  2.188215e-03                  HBP.bat:E
## 1595 2.181467e-03               RF.G:num_fas
## 1230 2.176445e-03                H.pitch:HR9
## 960  2.156239e-03                       SH:E
## 685  2.156064e-03                     OBP:PO
## 1022 2.152588e-03                IBB.bat:SO9
## 1029 2.149400e-03                  IBB.bat:E
## 890  2.139497e-03                  GDP:RF.9
## 549  2.127486e-03                BB.bat:SO.W
## 345  2.101459e-03               X3B:HR.pitch
## 1529 2.089996e-03           SO.W:tot_fa_war3
## 877  2.086516e-03                     GDP:H9
## 456  2.082562e-03                   SB:SO.W
## 944  2.078928e-03               SH:HBP.pitch
## 1228 2.065876e-03               H.pitch:WHIP
## 966  2.051849e-03                  SH:num_fas
## 610  2.047505e-03                  BA:OPSplus
## 495  2.046835e-03                       CS:WP
## 1284 2.035641e-03              BB.pitch:SO.W
```

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## 1515 2.032409e-03                 SO9:RF.9
## 856  1.998080e-03               GDP:HBP.bat
## 769  1.996051e-03                     OPS:A
## 935  1.984281e-03                     SH:GF
## 462  1.978336e-03                      SB:E
## 589  1.972888e-03               SO.bat:WHIP
## 45   1.967453e-03                         G
## 34   1.957202e-03                 HBP.pitch
## 547  1.942129e-03                BB.bat:BB9
## 1056 1.922717e-03            Age.pitch:SO.W
## 1083 1.918538e-03       W.L..same_year:WHIP
## 558  1.903707e-03                BB.bat:RF.9
## 11   1.897721e-03                    SO.bat
## 501  1.884467e-03                    CS:BB9
## 896  1.877369e-03           HBP.bat:IBB.bat
## 1259 1.875606e-03             HR.pitch:SO.W
## 471  1.859294e-03                     CS:BA
## 1319 1.856077e-03     IBB.pitch:tot_fa_war3
## 31   1.855758e-03                 BB.pitch
## 306  1.849420e-03                   X2B:HR9
## 1292 1.845702e-03            BB.pitch:Fld.
## 318  1.838386e-03                 X2B:RF.9
## 576  1.825671e-03                SO.bat:SHO
## 399  1.807813e-03                 HR.bat:BK
## 684  1.796925e-03                    OBP:Ch
## 1393 1.786366e-03                    WP:SO9
## 786  1.778017e-03               OPSplus:SHO
## 857  1.775283e-03                    GDP:SH
## 1161 1.757524e-03               SHO:num_fas
## 391  1.749100e-03                  HR.bat:SV
## 1265 1.746943e-03                HR.pitch:E
## 965  1.742543e-03            SH:tot_fa_war3
## 1525 1.735650e-03                   SO.W:DP
## 398  1.735467e-03          HR.bat:HBP.pitch
## 25   1.727765e-03                        GF
## 434  1.724914e-03                SB:IBB.bat
## 386  1.723031e-03             HR.bat:IBB.bat
## 1258 1.709635e-03               HR.pitch:SO9
## 559  1.688454e-03                BB.bat:RF.G
## 771  1.683229e-03                    OPS:DP
## 1391 1.675120e-03                    WP:HR9
## 696  1.664500e-03                    SLG:TB
## 1001 1.662270e-03                SF:num_fas
## 1584 1.647751e-03                   DP:RF.G
## 30   1.640716e-03                  HR.pitch
## 1347 1.629623e-03             HBP.pitch:FIP
## 1203 1.628962e-03                    IP:HR9
## 1177 1.627414e-03                    SV:SO9
## 480  1.619299e-03                     CS:SF
## 930  1.614764e-03            HBP.bat:num_fas
## 871  1.612830e-03              GDP:HBP.pitch
## 738  1.608127e-03                    OPS:GDP
## 407  1.576861e-03                HR.bat:SO9
## 297  1.565294e-03              X2B:IBB.pitch
```

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## 304  1.561797e-03                 X2B:WHIP
## 29   1.558491e-03                   H.pitch
## 1139 1.554477e-03            SHO:HBP.pitch
## 950  1.552280e-03                    SH:H9
## 1224 1.548223e-03               H.pitch:BK
## 1253 1.545741e-03              HR.pitch:FIP
## 478  1.534247e-03               CS:HBP.bat
## 319  1.532275e-03                 X2B:RF.G
## 1201 1.527156e-03                  IP:WHIP
## 323  1.521972e-03                   X3B:SB
## 1111 1.517241e-03                    GF:WP
## 1322 1.514129e-03              SO.pitch:BK
## 1129 1.496046e-03                  GF:RF.G
## 591  1.494360e-03               SO.bat:HR9
## 1138 1.486067e-03              SHO:SO.pitch
## 948  1.477625e-03                   SH:FIP
## 1537 1.477014e-03                   G:Fld.
## 405  1.475841e-03               HR.bat:HR9
## 366  1.469543e-03                   X3B:DP
## 1133 1.468544e-03                   SHO:IP
## 324  1.465859e-03                   X3B:CS
## 756  1.463908e-03                   OPS:WP
## 1168 1.443365e-03              SV:HBP.pitch
## 683  1.440008e-03                   OBP:Inn
## 1214 1.434814e-03                   IP:Fld.
## 1390 1.419936e-03                    WP:H9
## 414  1.412539e-03                  HR.bat:E
## 384  1.396883e-03                 HR.bat:SH
## 1339 1.390862e-03              SO.pitch:Fld.
## 736  1.385194e-03                OPS:OPSplus
## 385  1.383992e-03                  HR.bat:SF
## 1255 1.370890e-03                HR.pitch:H9
## 893  1.363410e-03                GDP:num_fas
## 674  1.354634e-03                    OBP:BF
## 307  1.350229e-03                   X2B:BB9
## 1150 1.336684e-03                     SHO:G
## 271  1.332345e-03                   X2B:X3B
## 1443 1.326810e-03               FIP:num_fas
## 537  1.294049e-03          BB.bat:IBB.pitch
## 402  1.281541e-03                HR.bat:FIP
## 642  1.268907e-03                     BA:PO
## 322  1.264124e-03                X3B:HR.bat
## 1594 1.259241e-03          RF.G:tot_fa_war3
## 708  1.239783e-03               SLG:H.pitch
## 1592 1.229591e-03          RF.9:tot_fa_war3
## 1455 1.226303e-03                   WHIP:DP
## 1405 1.226197e-03            WP:tot_fa_war3
## 365  1.225536e-03                    X3B:E
## 525  1.208556e-03                 BB.bat:SH
## 1364 1.198429e-03      HBP.pitch:tot_fa_war3
## 640  1.195582e-03                   BA:Inn
## 91   1.189913e-03                Age.bat:WP
## 1314 1.188870e-03               IBB.pitch:E
## 1115 1.179264e-03                    GF:H9
```

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## 641  1.169560e-03                   BA:Ch
## 602  1.162806e-03               SO.bat:Fld.
## 1504 1.151309e-03           BB9:tot_fa_war3
## 421  1.145865e-03                   SB:CS
## 543  1.138930e-03                BB.bat:FIP
## 894  1.132700e-03                HBP.bat:SH
## 1257 1.127710e-03              HR.pitch:BB9
## 1349 1.122185e-03              HBP.pitch:H9
## 727  1.114809e-03                   SLG:PO
## 489  1.104454e-03               CS:HR.pitch
## 454  1.100128e-03                   SB:BB9
## 64   1.097209e-03                Age.bat:CS
## 308  1.094679e-03                   X2B:SO9
## 1406 1.090148e-03                WP:num_fas
## 76   1.086260e-03                Age.bat:SF
## 1088 1.078636e-03       W.L..same_year:SO.W
## 1166 1.069725e-03              SV:IBB.pitch
## 33   1.050307e-03                  SO.pitch
## 1593 1.046548e-03              RF.9:num_fas
## 1233 1.037210e-03              H.pitch:SO.W
## 726  1.036484e-03                   SLG:Ch
## 514  1.027935e-03           CS:tot_fa_war3
## 351  1.027199e-03                   X3B:WP
## 564  1.024907e-03                SO.bat:SLG
## 451  1.020717e-03                   SB:WHIP
## 867  1.018907e-03              GDP:HR.pitch
## 995  1.017832e-03                     SF:E
## 585  1.002447e-03                SO.bat:BK
## 339  1.001316e-03        X3B:W.L..same_year
## 548  9.995998e-04                BB.bat:SO9
## 446  9.938867e-04              SB:HBP.pitch
## 1317 9.931919e-04           IBB.pitch:RF.9
## 292  9.886746e-04                   X2B:SV
## 1062 9.880915e-04                Age.pitch:E
## 484  9.737559e-04                     CS:GF
## 1269 9.736958e-04              HR.pitch:RF.G
## 799  9.685419e-04              OPSplus:WHIP
## 1154 9.665059e-04                     SHO:A
## 1583 9.620924e-04                   DP:RF.9
## 373  9.600386e-04                HR.bat:CS
## 737  9.531035e-04                   OPS:TB
## 1030 9.499496e-04                IBB.bat:DP
## 1097 9.464127e-04       W.L..same_year:RF.9
## 1197 9.426431e-04                     IP:BK
## 98   9.367282e-04               Age.bat:SO9
## 880  9.365559e-04                   GDP:SO9
## 539  9.283369e-04          BB.bat:HBP.pitch
## 532  9.210712e-04                BB.bat:SV
## 1039 9.107424e-04              Age.pitch:SV
## 631  9.100427e-04                     BA:BF
## 1035 9.096179e-04           IBB.bat:num_fas
## 400  9.077711e-04                HR.bat:WP
## 725  9.028652e-04                  SLG:Inn
## 1365 8.859370e-04         HBP.pitch:num_fas
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## 433  8.837557e-04                   SB:SF
## 1476 8.834622e-04               H9:num_fas
## 1352 8.819585e-04             HBP.pitch:SO9
## 342  8.784783e-04                   X3B:SV
## 1351 8.562186e-04             HBP.pitch:BB9
## 795  8.440549e-04                OPSplus:BK
## 996  8.415668e-04                     SF:DP
## 249  8.345075e-04                  H.bat:BK
## 926  8.343762e-04              HBP.bat:Fld.
## 382  8.325293e-04                HR.bat:GDP
## 851  8.299690e-04                   TB:Fld.
## 338  8.284877e-04             X3B:Age.pitch
## 917  8.258267e-04               HBP.bat:SO9
## 929  8.202741e-04       HBP.bat:tot_fa_war3
## 531  8.113239e-04                BB.bat:SHO
## 563  8.099289e-04                SO.bat:OBP
## 226  8.017366e-04                  H.bat:BA
## 541  7.915056e-04                BB.bat:WP
## 941  7.903496e-04               SH:BB.pitch
## 555  7.884828e-04                  BB.bat:E
## 1363 7.825607e-04            HBP.pitch:RF.G
## 315  7.805473e-04                     X2B:E
## 73   7.646534e-04               Age.bat:GDP
## 1243 7.582257e-04              H.pitch:RF.G
## 285  7.547014e-04                   X2B:SH
## 1442 7.540511e-04           FIP:tot_fa_war3
## 1440 7.520984e-04                   FIP:RF.9
## 863  7.484824e-04                  GDP:SHO
## 1019 7.480219e-04                IBB.bat:H9
## 716  7.411407e-04                    SLG:BF
## 1528 7.309558e-04                 SO.W:RF.G
## 623  7.255488e-04                BA:H.pitch
## 905  7.244350e-04          HBP.bat:BB.pitch
## 174  7.235598e-04                    AB:BA
## 927  7.199528e-04               HBP.bat:RF.9
## 465  7.151870e-04                    SB:RF.9
## 502  7.150234e-04                    CS:SO9
## 1518 7.129651e-04               SO9:num_fas
## 951  7.072920e-04                    SH:HR9
## 1107 7.050620e-04               GF:IBB.pitch
## 1328 6.895026e-04               SO.pitch:HR9
## 825  6.880169e-04                    TB:SHO
## 1580 6.844749e-04             E:tot_fa_war3
## 303  6.821577e-04                   X2B:FIP
## 1283 6.773103e-04               BB.pitch:SO9
## 1517 6.766250e-04           SO9:tot_fa_war3
## 326  6.743287e-04                X3B:SO.bat
## 604  6.730971e-04               SO.bat:RF.G
## 873  6.696880e-04                    GDP:WP
## 888  6.672545e-04                    GDP:DP
## 963  6.649380e-04                   SH:RF.9
## 227  6.646416e-04                  H.bat:OBP
## 1326 6.603846e-04               SO.pitch:WHIP
## 1070 6.554447e-04          W.L..same_year:SHO
```

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## 1268 6.551642e-04             HR.pitch:RF.9
## 1086 6.538811e-04        W.L..same_year:BB9
## 1134 6.469753e-04               SHO:H.pitch
## 1449 6.428223e-04                    WHIP:G
## 301  6.267143e-04                    X2B:WP
## 1000 6.222292e-04           SF:tot_fa_war3
## 1519 6.115972e-04                    SO.W:G
## 1470 6.043771e-04                      H9:E
## 1307 6.032128e-04             IBB.pitch:SO9
## 1294 6.022440e-04             BB.pitch:RF.G
## 812  5.916939e-04              OPSplus:Fld.
## 1118 5.916236e-04                    GF:SO9
## 1232 5.878422e-04               H.pitch:SO9
## 801  5.874979e-04               OPSplus:HR9
## 455  5.805097e-04                    SB:SO9
## 565  5.796572e-04              SO.bat:OPS
## 121  5.795734e-04                   PA:BA
## 881  5.722077e-04                GDP:SO.W
## 389  5.646829e-04               HR.bat:GF
## 105  5.617958e-04               Age.bat:E
## 1119 5.617882e-04                 GF:SO.W
## 1102 5.600705e-04                   GF:SV
## 1084 5.599343e-04         W.L..same_year:H9
## 768  5.593608e-04                  OPS:PO
## 1153 5.580044e-04                  SHO:PO
## 371  5.574062e-04              X3B:num_fas
## 1189 5.545680e-04           SV:tot_fa_war3
## 1013 5.528365e-04         IBB.bat:HBP.pitch
## 448  5.494246e-04                    SB:WP
## 969  5.451947e-04         SF:W.L..same_year
## 1017 5.423816e-04              IBB.bat:FIP
## 404  5.399042e-04                HR.bat:H9
## 74   5.392477e-04           Age.bat:HBP.bat
## 1216 5.378540e-04                   IP:RF.G
## 864  5.367082e-04                   GDP:SV
## 976  5.267701e-04              SF:BB.pitch
## 286  5.231619e-04                    X2B:SF
## 968  5.222082e-04             SF:Age.pitch
## 767  5.187441e-04                   OPS:Ch
## 1530 5.184356e-04              SO.W:num_fas
## 82   5.119957e-04                Age.bat:SV
## 1276 5.090009e-04               BB.pitch:WP
## 1403 5.084263e-04                   WP:RF.9
## 1227 5.063890e-04               H.pitch:FIP
## 1337 5.034580e-04                SO.pitch:E
## 1340 5.025792e-04             SO.pitch:RF.9
## 325  5.009480e-04                X3B:BB.bat
## 1280 4.970136e-04               BB.pitch:H9
## 477  4.950035e-04                    CS:GDP
## 19   4.943543e-04                   HBP.bat
## 473  4.935930e-04                    CS:SLG
## 1050 4.928483e-04             Age.pitch:FIP
## 266  4.921093e-04                H.bat:Fld.
## 255  4.902190e-04                  H.bat:HR9
```

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## 87   4.898534e-04          Age.bat:IBB.pitch
## 584  4.860972e-04          SO.bat:HBP.pitch
## 240  4.852125e-04                 H.bat:SHO
## 766  4.829232e-04                   OPS:Inn
## 527  4.822145e-04            BB.bat:IBB.bat
## 1278 4.796754e-04              BB.pitch:FIP
## 1471 4.789087e-04                     H9:DP
## 1272 4.785467e-04        BB.pitch:IBB.pitch
## 1034 4.775435e-04       IBB.bat:tot_fa_war3
## 925  4.767796e-04               HBP.bat:DP
## 1249 4.707955e-04        HR.pitch:HBP.pitch
## 85   4.685619e-04          Age.bat:HR.pitch
## 1021 4.658610e-04               IBB.bat:BB9
## 1494 4.653145e-04                     BB9:G
## 1242 4.652067e-04              H.pitch:RF.9
## 588  4.641559e-04              SO.bat:FIP
## 1117 4.579601e-04                  GF:BB9
## 1432 4.577783e-04                   FIP:G
## 1290 4.567320e-04              BB.pitch:E
## 437  4.559320e-04                   SB:GF
## 1315 4.547381e-04              IBB.pitch:DP
## 1401 4.540291e-04                   WP:DP
## 749  4.513551e-04              OPS:H.pitch
## 524  4.486679e-04            BB.bat:HBP.bat
## 1048 4.483117e-04              Age.pitch:WP
## 1231 4.465730e-04              H.pitch:BB9
## 970  4.454504e-04                   SF:GF
## 1379 4.365423e-04                    BK:A
## 545  4.333228e-04                BB.bat:H9
## 1164 4.317467e-04              SV:HR.pitch
## 571  4.303169e-04                SO.bat:SF
## 603  4.296570e-04              SO.bat:RF.9
## 346  4.288972e-04              X3B:BB.pitch
## 952  4.280492e-04                   SH:BB9
## 1010 4.249818e-04          IBB.bat:BB.pitch
## 510  4.147097e-04                   CS:DP
## 1125 4.138632e-04                    GF:E
## 340  4.098699e-04                  X3B:GF
## 17   4.081099e-04                      TB
## 1094 4.054578e-04          W.L..same_year:E
## 452  4.017398e-04                   SB:H9
## 1225 4.009205e-04                H.pitch:WP
## 299  3.999668e-04             X2B:HBP.pitch
## 387  3.996015e-04          HR.bat:Age.pitch
## 253  3.993063e-04                H.bat:WHIP
## 843  3.964315e-04                   TB:SO.W
## 283  3.946560e-04                  X2B:GDP
## 1480 3.869188e-04                    HR9:G
## 331  3.844166e-04               X3B:OPSplus
## 1054 3.826645e-04             Age.pitch:BB9
## 1152 3.810854e-04                   SHO:Ch
## 1271 3.809931e-04          HR.pitch:num_fas
## 89   3.779502e-04          Age.bat:HBP.pitch
## 1513 3.719013e-04                   SO9:DP
```

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## 258  3.708808e-04                H.bat:SO.W
## 1113 3.702262e-04                    GF:FIP
## 1087 3.673094e-04        W.L..same_year:SO9
## 933  3.670644e-04             SH:Age.pitch
## 78   3.648410e-04         Age.bat:Age.pitch
## 442  3.634461e-04               SB:HR.pitch
## 203  3.616122e-04                   AB:HR9
## 592  3.603592e-04                SO.bat:BB9
## 201  3.581348e-04                   AB:WHIP
## 1105 3.575426e-04               GF:HR.pitch
## 1229 3.548709e-04                H.pitch:H9
## 1002 3.544346e-04         IBB.bat:Age.pitch
## 228  3.537221e-04                 H.bat:SLG
## 938  3.535174e-04                     SH:IP
## 572  3.506167e-04            SO.bat:IBB.bat
## 757  3.505350e-04                   OPS:BF
## 590  3.494825e-04                SO.bat:H9
## 1082 3.479430e-04        W.L..same_year:FIP
## 68   3.470403e-04               Age.bat:OBP
## 467  3.467187e-04            SB:tot_fa_war3
## 176  3.397240e-04                   AB:SLG
## 530  3.393834e-04                BB.bat:GF
## 220  3.350926e-04                H.bat:X3B
## 1055 3.330672e-04             Age.pitch:SO9
## 804  3.321939e-04              OPSplus:SO.W
## 99   3.285301e-04              Age.bat:SO.W
## 1329 3.248495e-04              SO.pitch:BB9
## 1475 3.232792e-04            H9:tot_fa_war3
## 946  3.232037e-04                     SH:WP
## 1046 3.230105e-04       Age.pitch:HBP.pitch
## 364  3.222680e-04                     X3B:A
## 1078 3.183363e-04   W.L..same_year:HBP.pitch
## 1223 3.171056e-04        H.pitch:HBP.pitch
## 512  3.169369e-04                  CS:RF.9
## 28   3.134310e-04                       IP
## 1538 3.128059e-04                   G:RF.9
## 1274 3.117599e-04        BB.pitch:HBP.pitch
## 287  3.111228e-04               X2B:IBB.bat
## 3    3.108660e-04                       AB
## 1080 3.098744e-04         W.L..same_year:WP
## 75   3.081867e-04               Age.bat:SH
## 887  3.080805e-04                    GDP:E
## 1202 3.070078e-04                    IP:H9
## 214  3.067467e-04                  AB:Fld.
## 4    3.056706e-04                    H.bat
## 1198 3.018831e-04                    IP:WP
## 197  2.954166e-04                    AB:BK
## 535  2.953310e-04           BB.bat:HR.pitch
## 274  2.944174e-04                  X2B:CS
## 939  2.919948e-04               SH:H.pitch
## 49   2.917957e-04                       A
## 1142 2.885279e-04                  SHO:BF
## 290  2.838869e-04                  X2B:GF
## 1200 2.834811e-04                  IP:FIP
```

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## 898  2.792634e-04     HBP.bat:W.L..same_year
## 1071 2.776350e-04          W.L..same_year:SV
## 1109 2.754002e-04               GF:HBP.pitch
## 1354 2.738315e-04                HBP.pitch:G
## 1251 2.719025e-04                HR.pitch:WP
## 1507 2.712583e-04                      SO9:G
## 1221 2.694762e-04          H.pitch:IBB.pitch
## 814  2.687264e-04               OPSplus:RF.G
## 348  2.671257e-04               X3B:SO.pitch
## 1206 2.667228e-04                    IP:SO.W
## 978  2.665549e-04                SF:SO.pitch
## 295  2.649551e-04               X2B:HR.pitch
## 430  2.617608e-04                     SB:GDP
## 1131 2.602399e-04                GF:num_fas
## 383  2.565801e-04             HR.bat:HBP.bat
## 1033 2.558643e-04                IBB.bat:RF.G
## 246  2.550828e-04             H.bat:IBB.pitch
## 831  2.535992e-04                TB:IBB.pitch
## 868  2.520259e-04                GDP:BB.pitch
## 796  2.497988e-04                  OPSplus:WP
## 284  2.488699e-04                X2B:HBP.bat
## 974  2.481955e-04                 SF:H.pitch
## 1358 2.477642e-04                HBP.pitch:A
## 370  2.465944e-04            X3B:tot_fa_war3
## 235  2.452167e-04                   H.bat:SF
## 46   2.443407e-04                        Inn
## 150  2.440482e-04                     PA:HR9
## 469  2.435715e-04                   CS:BB.bat
## 123  2.433180e-04                      PA:SLG
## 568  2.384997e-04                 SO.bat:GDP
## 528  2.348376e-04           BB.bat:Age.pitch
## 838  2.345881e-04                    TB:WHIP
## 63   2.344177e-04                 Age.bat:SB
## 903  2.314280e-04             HBP.bat:H.pitch
## 148  2.306099e-04                    PA:WHIP
## 490  2.295886e-04                 CS:BB.pitch
## 492  2.270951e-04                 CS:SO.pitch
## 1296 2.247118e-04           BB.pitch:num_fas
## 1174 2.229152e-04                      SV:H9
## 1297 2.228541e-04         IBB.pitch:SO.pitch
## 961  2.193915e-04                      SH:DP
## 1341 2.190045e-04              SO.pitch:RF.G
## 1596 2.188505e-04         tot_fa_war3:num_fas
## 1247 2.181718e-04          HR.pitch:IBB.pitch
## 1215 2.178599e-04                    IP:RF.9
## 360  2.169200e-04                      X3B:G
## 335  2.139085e-04                     X3B:SH
## 1282 2.126679e-04                BB.pitch:BB9
## 1323 2.112754e-04                 SO.pitch:WP
## 2    2.082842e-04                         PA
## 781  2.079667e-04                  OPSplus:SF
## 892  2.075942e-04             GDP:tot_fa_war3
## 1378 2.070464e-04                      BK:PO
## 1498 2.069831e-04                      BB9:A
```

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## 468  2.062473e-04                SB:num_fas
## 1327 2.048245e-04               SO.pitch:H9
## 859  2.038502e-04               GDP:IBB.bat
## 1399 2.028646e-04                      WP:A
## 1573 2.026101e-04                   A:RF.G
## 852  2.016948e-04                  TB:RF.9
## 435  2.003015e-04              SB:Age.pitch
## 175  1.997961e-04                    AB:OBP
## 994  1.994738e-04                     SF:A
## 288  1.979659e-04             X2B:Age.pitch
## 470  1.956617e-04                 CS:SO.bat
## 1331 1.924309e-04             SO.pitch:SO.W
## 144  1.916763e-04                    PA:BK
## 482  1.910135e-04              CS:Age.pitch
## 1535 1.900444e-04                       G:E
## 810  1.880188e-04                OPSplus:E
## 582  1.875543e-04          SO.bat:IBB.pitch
## 841  1.862606e-04                   TB:BB9
## 800  1.822801e-04                OPSplus:H9
## 1205 1.815804e-04                    IP:SO9
## 466  1.815732e-04                  SB:RF.G
## 577  1.813934e-04                 SO.bat:SV
## 1395 1.789810e-04                      WP:G
## 77   1.785368e-04           Age.bat:IBB.bat
## 1436 1.776537e-04                    FIP:A
## 450  1.774157e-04                   SB:FIP
## 111  1.772800e-04           Age.bat:num_fas
## 860  1.767674e-04             GDP:Age.pitch
## 861  1.756054e-04        GDP:W.L..same_year
## 1028 1.754415e-04                 IBB.bat:A
## 1586 1.754378e-04                DP:num_fas
## 443  1.714492e-04               SB:BB.pitch
## 177  1.707935e-04                    AB:OPS
## 943  1.706570e-04               SH:SO.pitch
## 1076 1.680678e-04   W.L..same_year:IBB.pitch
## 1547 1.670016e-04                  Inn:Fld.
## 1483 1.664545e-04                    HR9:PO
## 223  1.660843e-04                 H.bat:CS
## 1012 1.653786e-04          IBB.bat:SO.pitch
## 1360 1.616228e-04              HBP.pitch:DP
## 1037 1.613972e-04              Age.pitch:GF
## 1151 1.581174e-04                   SHO:Inn
## 990  1.580477e-04                      SF:G
## 487  1.575418e-04                     CS:IP
## 1321 1.574833e-04        SO.pitch:HBP.pitch
## 819  1.568813e-04                     TB:SH
## 1185 1.555740e-04                     SV:DP
## 1036 1.544556e-04   Age.pitch:W.L..same_year
## 394  1.525406e-04           HR.bat:HR.pitch
## 1044 1.476343e-04       Age.pitch:IBB.pitch
## 188  1.469998e-04                    AB:SHO
## 1421 1.448780e-04                  BF:Fld.
## 106  1.425089e-04                Age.bat:DP
## 1130 1.415120e-04            GF:tot_fa_war3
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## 973  1.415097e-04                   SF:IP
## 826  1.413796e-04                   TB:SV
## 853  1.412410e-04                 TB:RF.G
## 232  1.411198e-04               H.bat:GDP
## 415  1.390287e-04               HR.bat:DP
## 1581 1.386941e-04               E:num_fas
## 48   1.362091e-04                      PO
## 570  1.354994e-04               SO.bat:SH
## 1500 1.346870e-04                  BB9:DP
## 569  1.340652e-04          SO.bat:HBP.bat
## 1392 1.330510e-04                  WP:BB9
## 422  1.326677e-04               SB:BB.bat
## 66   1.325781e-04          Age.bat:SO.bat
## 1008 1.315763e-04         IBB.bat:H.pitch
## 272  1.312840e-04              X2B:HR.bat
## 842  1.310253e-04                  TB:SO9
## 388  1.310062e-04    HR.bat:W.L..same_year
## 267  1.304661e-04              H.bat:RF.9
## 305  1.300084e-04                  X2B:H9
## 216  1.290257e-04                 AB:RF.G
## 1484 1.279226e-04                   HR9:A
## 606  1.274336e-04          SO.bat:num_fas
## 86   1.273345e-04        Age.bat:BB.pitch
## 233  1.271941e-04           H.bat:HBP.bat
## 580  1.270733e-04         SO.bat:HR.pitch
## 463  1.250196e-04                  SB:DP
## 80   1.245082e-04              Age.bat:GF
## 586  1.242542e-04               SO.bat:WP
## 834  1.239441e-04                  TB:BK
## 787  1.235155e-04              OPSplus:SV
## 1204 1.233796e-04                  IP:BB9
## 1067 1.232132e-04    Age.pitch:tot_fa_war3
## 1024 1.219648e-04               IBB.bat:G
## 886  1.215214e-04                   GDP:A
## 798  1.214380e-04              OPSplus:FIP
## 431  1.212192e-04               SB:HBP.bat
## 432  1.200020e-04                   SB:SH
## 556  1.169936e-04               BB.bat:DP
## 790  1.155477e-04        OPSplus:HR.pitch
## 363  1.148043e-04                  X3B:PO
## 16   1.129833e-04                 OPSplus
## 1190 1.129399e-04               SV:num_fas
## 1571 1.127669e-04                   A:Fld.
## 445  1.121409e-04              SB:SO.pitch
## 1566 1.121259e-04                  PO:RF.G
## 124  1.119810e-04                   PA:OPS
## 778  1.117054e-04              OPSplus:GDP
## 1523 1.112798e-04                   SO.W:A
## 821  1.111983e-04               TB:IBB.bat
## 47   1.106496e-04                       Ch
## 168  1.099448e-04                   AB:X3B
## 1126 1.092542e-04                    GF:DP
## 1453 1.090807e-04                   WHIP:A
## 1196 1.074630e-04            IP:HBP.pitch
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## 135  1.072548e-04                  PA:SHO
## 1576 1.066664e-04                    E:DP
## 536  1.065960e-04           BB.bat:BB.pitch
## 779  1.065187e-04           OPSplus:HBP.bat
## 374  1.057967e-04             HR.bat:BB.bat
## 1163 1.048384e-04                SV:H.pitch
## 257  1.045757e-04                H.bat:SO9
## 110  1.041634e-04       Age.bat:tot_fa_war3
## 115  1.039545e-04                PA:X3B
## 813  1.025878e-04              OPSplus:RF.9
## 1179 1.024985e-04                     SV:G
## 1388 1.023350e-04                  WP:FIP
## 849  9.930110e-05                    TB:E
## 122  9.905589e-05                  PA:OBP
## 1309 9.904436e-05               IBB.pitch:G
## 1098 9.818638e-05       W.L..same_year:RF.G
## 882  9.751387e-05                  GDP:G
## 332  9.743438e-05                  X3B:TB
## 241  9.648852e-05                H.bat:SV
## 802  9.629201e-05               OPSplus:BB9
## 344  9.608984e-05               X3B:H.pitch
## 601  9.463519e-05                 SO.bat:DP
## 321  9.430988e-05               X2B:num_fas
## 200  9.402080e-05                    AB:FIP
## 1450 9.354157e-05                 WHIP:Inn
## 252  9.353305e-05                H.bat:FIP
## 993  9.185987e-05                    SF:PO
## 1320 9.124757e-05         IBB.pitch:num_fas
## 600  9.116327e-05                  SO.bat:E
## 397  9.101779e-05           HR.bat:SO.pitch
## 835  8.991732e-05                    TB:WP
## 372  8.917781e-05                HR.bat:SB
## 504  8.901373e-05                     CS:G
## 254  8.876657e-05                H.bat:H9
## 409  8.874232e-05                HR.bat:G
## 1194 8.839582e-05              IP:IBB.pitch
## 866  8.836889e-05              GDP:H.pitch
## 1585 8.815525e-05           DP:tot_fa_war3
## 955  8.811693e-05                    SH:G
## 1482 8.803133e-05                  HR9:Ch
## 837  8.777999e-05                  TB:FIP
## 395  8.766055e-05           HR.bat:BB.pitch
## 1558 8.672783e-05                  Ch:RF.G
## 362  8.603431e-05                  X3B:Ch
## 84   8.591073e-05           Age.bat:H.pitch
## 1165 8.580147e-05               SV:BB.pitch
## 264  8.407936e-05                  H.bat:E
## 1068 8.383826e-05         Age.pitch:num_fas
## 840  8.357301e-05                  TB:HR9
## 436  8.332706e-05         SB:W.L..same_year
## 1245 8.311888e-05           H.pitch:num_fas
## 1411 8.310905e-05                  BF:BB9
## 870  8.210803e-05              GDP:SO.pitch
## 37   8.175219e-05                       BF
```

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## 1520 8.168827e-05                  SO.W:Inn
## 899  8.096916e-05                HBP.bat:GF
## 1099 8.096622e-05 W.L..same_year:tot_fa_war3
## 215  8.078151e-05                   AB:RF.9
## 161  8.041974e-05                   PA:Fld.
## 248  8.034881e-05            H.bat:HBP.pitch
## 1438 7.936614e-05                    FIP:DP
## 919  7.889581e-05                 HBP.bat:G
## 529  7.872974e-05      BB.bat:W.L..same_year
## 273  7.819721e-05                    X2B:SB
## 413  7.789409e-05                  HR.bat:A
## 1375 7.781226e-05                      BK:G
## 343  7.762445e-05                    X3B:IP
## 423  7.759625e-05                 SB:SO.bat
## 392  7.699036e-05                 HR.bat:IP
## 1009 7.668723e-05           IBB.bat:HR.pitch
## 593  7.583745e-05                 SO.bat:SO9
## 1074 7.569592e-05    W.L..same_year:HR.pitch
## 1057 7.559062e-05                Age.pitch:G
## 419  7.531894e-05         HR.bat:tot_fa_war3
## 1325 7.421996e-05               SO.pitch:FIP
## 183  7.205291e-05                     AB:SF
## 1469 7.204745e-05                      H9:A
## 475  7.175404e-05                 CS:OPSplus
## 972  7.165337e-05                     SF:SV
## 1219 7.108242e-05           H.pitch:HR.pitch
## 833  7.089022e-05               TB:HBP.pitch
## 1419 7.023385e-05                      BF:E
## 204  7.022203e-05                    AB:BB9
## 1522 6.974288e-05                   SO.W:PO
## 62   6.958732e-05             Age.bat:HR.bat
## 1377 6.929617e-05                      BK:Ch
## 1212 6.915058e-05                      IP:E
## 1422 6.856211e-05                    BF:RF.9
## 440  6.847461e-05                      SB:IP
## 1511 6.846374e-05                      SO9:A
## 229  6.820632e-05                  H.bat:OPS
## 897  6.734639e-05          HBP.bat:Age.pitch
## 65   6.711731e-05             Age.bat:BB.bat
## 71   6.708864e-05           Age.bat:OPSplus
## 1248 6.681694e-05          HR.pitch:SO.pitch
## 947  6.678356e-05                     SH:BF
## 992  6.418591e-05                     SF:Ch
## 1569 6.349213e-05                       A:E
## 202  6.318726e-05                     AB:H9
## 256  6.263637e-05                  H.bat:BB9
## 816  6.202844e-05            OPSplus:num_fas
## 1246 6.128921e-05          HR.pitch:BB.pitch
## 508  6.071769e-05                      CS:A
## 780  6.059419e-05                OPSplus:SH
## 1095 6.056162e-05          W.L..same_year:DP
## 196  6.026806e-05               AB:HBP.pitch
## 130  6.021299e-05                     PA:SF
## 1481 5.962835e-05                   HR9:Inn
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## 163  5.937207e-05                  PA:RF.G
## 538  5.929599e-05            BB.bat:SO.pitch
## 1435 5.899915e-05                    FIP:PO
## 147  5.870638e-05                    PA:FIP
## 234  5.868789e-05                  H.bat:SH
## 820  5.827369e-05                     TB:SF
## 1495 5.813873e-05                   BB9:Inn
## 1433 5.718122e-05                   FIP:Inn
## 959  5.683299e-05                      SH:A
## 222  5.657719e-05                  H.bat:SB
## 420  5.585966e-05             HR.bat:num_fas
## 1218 5.532292e-05                 IP:num_fas
## 581  5.479063e-05            SO.bat:BB.pitch
## 1434 5.464609e-05                    FIP:Ch
## 885  5.437426e-05                    GDP:PO
## 1398 5.434892e-05                     WP:PO
## 594  5.412001e-05                SO.bat:SO.W
## 298  5.409790e-05               X2B:SO.pitch
## 270  5.351172e-05              H.bat:num_fas
## 1312 5.346065e-05               IBB.pitch:PO
## 794  5.314635e-05          OPSplus:HBP.pitch
## 1496 5.275856e-05                    BB9:Ch
## 1521 5.271878e-05                   SO.W:Ch
## 1497 5.137062e-05                    BB9:PO
## 457  5.116506e-05                      SB:G
## 575  5.104256e-05                  SO.bat:GF
## 276  5.095278e-05                 X2B:SO.bat
## 550  5.070882e-05                   BB.bat:G
## 171  4.927493e-05                      AB:CS
## 60   4.875842e-05                Age.bat:X2B
## 221  4.866054e-05               H.bat:HR.bat
## 1167 4.776711e-05                SV:SO.pitch
## 1240 4.767634e-05                  H.pitch:DP
## 1063 4.765371e-05               Age.pitch:DP
## 824  4.760395e-05                     TB:GF
## 153  4.694649e-05                    PA:SO.W
## 817  4.682711e-05                    TB:GDP
## 1260 4.677893e-05                 HR.pitch:G
## 982  4.605140e-05                      SF:BF
## 118  4.587318e-05                      PA:CS
## 1397 4.574791e-05                     WP:Ch
## 811  4.572829e-05                 OPSplus:DP
## 923  4.432703e-05                  HBP.bat:A
## 1264 4.417642e-05                 HR.pitch:A
## 1069 4.404473e-05           W.L..same_year:GF
## 907  4.362132e-05            HBP.bat:SO.pitch
## 1342 4.357459e-05         SO.pitch:tot_fa_war3
## 310  4.335283e-05                     X2B:G
## 1357 4.328049e-05               HBP.pitch:PO
## 141  4.326987e-05               PA:IBB.pitch
## 1213 4.318308e-05                     IP:DP
## 1356 4.296627e-05               HBP.pitch:Ch
## 149  4.285859e-05                     PA:H9
## 1003 4.197434e-05      IBB.bat:W.L..same_year
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## 533  4.177614e-05                 BB.bat:IP
## 180  4.168863e-05                    AB:GDP
## 1556 4.020775e-05                  Ch:Fld.
## 1330 4.006428e-05               SO.pitch:SO9
## 1266 3.959976e-05                HR.pitch:DP
## 573  3.925483e-05           SO.bat:Age.pitch
## 1104 3.865743e-05                 GF:H.pitch
## 554  3.849805e-05                   BB.bat:A
## 1220 3.845417e-05           H.pitch:BB.pitch
## 1407 3.827903e-05                     BF:FIP
## 1343 3.825534e-05           SO.pitch:num_fas
## 523  3.800550e-05                 BB.bat:GDP
## 884  3.790053e-05                     GDP:Ch
## 1239 3.744620e-05                  H.pitch:E
## 289  3.726928e-05         X2B:W.L..same_year
## 1468 3.718149e-05                      H9:PO
## 194  3.713606e-05               AB:IBB.pitch
## 792  3.702333e-05          OPSplus:IBB.pitch
## 862  3.674861e-05                     GDP:GF
## 1355 3.632008e-05              HBP.pitch:Inn
## 1346 3.608086e-05               HBP.pitch:BF
## 1508 3.594263e-05                    SO9:Inn
## 127  3.578009e-05                     PA:GDP
## 181  3.572801e-05                 AB:HBP.bat
## 296  3.562871e-05               X2B:BB.pitch
## 1548 3.542046e-05                   Inn:RF.9
## 143  3.519262e-05               PA:HBP.pitch
## 293  3.518234e-05                     X2B:IP
## 822  3.468052e-05               TB:Age.pitch
## 83   3.447162e-05                 Age.bat:IP
## 1041 3.389163e-05          Age.pitch:H.pitch
## 782  3.378724e-05            OPSplus:IBB.bat
## 1045 3.359792e-05         Age.pitch:SO.pitch
## 791  3.359479e-05           OPSplus:BB.pitch
## 1465 3.324323e-05                       H9:G
## 1075 3.322158e-05    W.L..same_year:BB.pitch
## 1574 3.312379e-05              A:tot_fa_war3
## 198  3.308922e-05                     AB:WP
## 441  3.298814e-05                 SB:H.pitch
## 1004 3.225130e-05                 IBB.bat:GF
## 1293 3.184151e-05               BB.pitch:RF.9
## 605  3.126739e-05         SO.bat:tot_fa_war3
## 1295 3.028300e-05       BB.pitch:tot_fa_war3
## 829  3.001857e-05                 TB:HR.pitch
## 1410 2.996426e-05                     BF:HR9
## 1073 2.984205e-05     W.L..same_year:H.pitch
## 375  2.925109e-05               HR.bat:SO.bat
## 1396 2.897806e-05                     WP:Inn
## 488  2.871470e-05                 CS:H.pitch
## 865  2.845150e-05                     GDP:IP
## 88   2.818466e-05           Age.bat:SO.pitch
## 1311 2.788636e-05               IBB.pitch:Ch
## 803  2.787525e-05                OPSplus:SO9
## 1291 2.744525e-05                BB.pitch:DP
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## 128  2.720957e-05                PA:HBP.bat
## 1222 2.688009e-05           H.pitch:SO.pitch
## 1572 2.685953e-05                     A:RF.9
## 1540 2.678575e-05              G:tot_fa_war3
## 815  2.677746e-05        OPSplus:tot_fa_war3
## 1183 2.671918e-05                      SV:A
## 265  2.657163e-05                   H.bat:DP
## 496  2.642598e-05                      CS:BF
## 59   2.633062e-05              Age.bat:H.bat
## 534  2.623602e-05             BB.bat:H.pitch
## 361  2.578538e-05                    X3B:Inn
## 393  2.577583e-05             HR.bat:H.pitch
## 250  2.560408e-05                   H.bat:WP
## 218  2.556300e-05                 AB:num_fas
## 151  2.554408e-05                     PA:BB9
## 1564 2.544848e-05                    PO:Fld.
## 275  2.544316e-05                 X2B:BB.bat
## 1120 2.540012e-05                       GF:G
## 1467 2.539447e-05                      H9:Ch
## 352  2.535786e-05                     X3B:BF
## 1510 2.482589e-05                     SO9:PO
## 579  2.460915e-05             SO.bat:H.pitch
## 136  2.438998e-05                      PA:SV
## 1026 2.403398e-05                 IBB.bat:Ch
## 1061 2.397850e-05                Age.pitch:A
## 314  2.396191e-05                      X2B:A
## 461  2.370503e-05                       SB:A
## 1509 2.317386e-05                     SO9:Ch
## 1040 2.292648e-05               Age.pitch:IP
## 1545 2.282105e-05                      Inn:E
## 911  2.272782e-05                 HBP.bat:BF
## 991  2.242207e-05                     SF:Inn
## 1367 2.227648e-05                      BK:BF
## 268  2.196997e-05                 H.bat:RF.G
## 521  2.178219e-05             BB.bat:OPSplus
## 320  2.155422e-05           X2B:tot_fa_war3
## 1273 2.135543e-05          BB.pitch:SO.pitch
## 58   2.124410e-05                 Age.bat:AB
## 162  2.121615e-05                    PA:RF.9
## 1376 2.079689e-05                     BK:Inn
## 1042 2.068966e-05         Age.pitch:HR.pitch
## 1310 2.068888e-05              IBB.pitch:Inn
## 79   2.061580e-05     Age.bat:W.L..same_year
## 560  2.056129e-05         BB.bat:tot_fa_war3
## 1562 2.025445e-05                      PO:E
## 1027 2.023805e-05                 IBB.bat:PO
## 1124 2.015566e-05                      GF:A
## 1089 1.997069e-05           W.L..same_year:G
## 1536 1.966040e-05                      G:DP
## 1338 1.900608e-05                SO.pitch:DP
## 165  1.896741e-05                 PA:num_fas
## 189  1.894749e-05                      AB:SV
## 1043 1.851238e-05         Age.pitch:BB.pitch
## 855  1.840856e-05                 TB:num_fas
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## 1025 1.835868e-05               IBB.bat:Inn
## 1451 1.829740e-05                   WHIP:Ch
## 316  1.824731e-05                    X2B:DP
## 1541 1.822255e-05                 G:num_fas
## 244  1.821517e-05            H.bat:HR.pitch
## 1182 1.816842e-05                     SV:PO
## 1193 1.809999e-05               IP:BB.pitch
## 1423 1.807268e-05                   BF:RF.G
## 225  1.799877e-05             H.bat:SO.bat
## 1563 1.778574e-05                     PO:DP
## 839  1.755711e-05                     TB:H9
## 1332 1.745447e-05                SO.pitch:G
## 213  1.708777e-05                     AB:DP
## 1413 1.700530e-05                   BF:SO.W
## 783  1.697386e-05          OPSplus:Age.pitch
## 1409 1.680886e-05                     BF:H9
## 170  1.658733e-05                     AB:SB
## 57   1.650166e-05                Age.bat:PA
## 1452 1.645079e-05                   WHIP:PO
## 192  1.635648e-05               AB:HR.pitch
## 874  1.586747e-05                    GDP:BF
## 1128 1.578116e-05                   GF:RF.9
## 206  1.573416e-05                   AB:SO.W
## 1016 1.559799e-05                IBB.bat:BF
## 219  1.557737e-05                 H.bat:X2B
## 145  1.547085e-05                     PA:WP
## 205  1.543605e-05                    AB:SO9
## 117  1.538146e-05                     PA:SB
## 1108 1.537331e-05               GF:SO.pitch
## 818  1.536223e-05                TB:HBP.bat
## 1270 1.531515e-05       HR.pitch:tot_fa_war3
## 1557 1.520239e-05                   Ch:RF.9
## 1106 1.481786e-05               GF:BB.pitch
## 526  1.465574e-05                 BB.bat:SF
## 1162 1.464502e-05                     SV:IP
## 1192 1.456046e-05               IP:HR.pitch
## 1313 1.450975e-05               IBB.pitch:A
## 1565 1.450450e-05                   PO:RF.9
## 401  1.431304e-05                HR.bat:BF
## 412  1.407499e-05                HR.bat:PO
## 1554 1.399789e-05                     Ch:E
## 789  1.395207e-05            OPSplus:H.pitch
## 411  1.380060e-05                 HR.bat:Ch
## 380  1.371781e-05             HR.bat:OPSplus
## 239  1.353298e-05                  H.bat:GF
## 599  1.348776e-05                 SO.bat:A
## 1007 1.334235e-05                IBB.bat:IP
## 449  1.321418e-05                     SB:BF
## 1234 1.312102e-05                 H.pitch:G
## 281  1.305343e-05               X2B:OPSplus
## 1181 1.279545e-05                     SV:Ch
## 883  1.277495e-05                   GDP:Inn
## 1180 1.255078e-05                    SV:Inn
## 104  1.250060e-05                 Age.bat:A
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## 92   1.248678e-05                Age.bat:BF
## 1238 1.213509e-05                 H.pitch:A
## 574  1.212913e-05      SO.bat:W.L..same_year
## 1191 1.201968e-05                 IP:H.pitch
## 1217 1.200120e-05              IP:tot_fa_war3
## 169  1.156939e-05                  AB:HR.bat
## 553  1.156910e-05                 BB.bat:PO
## 1100 1.154885e-05     W.L..same_year:num_fas
## 1568 1.154734e-05                 PO:num_fas
## 583  1.137845e-05            SO.bat:SO.pitch
## 1575 1.137749e-05                  A:num_fas
## 237  1.135338e-05            H.bat:Age.pitch
## 566  1.130229e-05             SO.bat:OPSplus
## 1336 1.121227e-05                 SO.pitch:A
## 578  1.097174e-05                  SO.bat:IP
## 410  1.091227e-05                 HR.bat:Inn
## 160  1.073407e-05                      PA:DP
## 116  1.031712e-05                  PA:HR.bat
## 785  1.031056e-05                 OPSplus:GF
## 129  1.023398e-05                      PA:SH
## 793  1.019607e-05           OPSplus:SO.pitch
## 522  1.006901e-05                  BB.bat:TB
## 1555 9.958977e-06                      Ch:DP
## 72   9.848734e-06                 Age.bat:TB
## 920  9.813181e-06                HBP.bat:Inn
## 1195 9.704770e-06                 IP:SO.pitch
## 139  9.552909e-06                 PA:HR.pitch
## 1289 9.527176e-06                  BB.pitch:A
## 159  9.462704e-06                       PA:E
## 552  9.361061e-06                  BB.bat:Ch
## 1058 9.282695e-06              Age.pitch:Inn
## 230  9.159019e-06              H.bat:OPSplus
## 245  8.966900e-06             H.bat:BB.pitch
## 1077 8.713128e-06    W.L..same_year:SO.pitch
## 542  8.695644e-06                  BB.bat:BF
## 103  8.645057e-06                 Age.bat:PO
## 212  8.557614e-06                       AB:E
## 516  8.514453e-06              BB.bat:SO.bat
## 429  8.514204e-06                      SB:TB
## 830  8.133808e-06                TB:BB.pitch
## 184  8.119509e-06                 AB:IBB.bat
## 1567 7.908615e-06              PO:tot_fa_war3
## 832  7.822334e-06                 TB:SO.pitch
## 1211 7.703964e-06                       IP:A
## 1261 7.675310e-06               HR.pitch:Inn
## 131  7.633157e-06                 PA:IBB.bat
## 505  7.548196e-06                     CS:Inn
## 1560 7.497727e-06                 Ch:num_fas
## 1425 7.465480e-06                 BF:num_fas
## 1285 7.420449e-06                 BB.pitch:G
## 823  7.386719e-06          TB:W.L..same_year
## 1060 7.165730e-06               Age.pitch:PO
## 561  7.139089e-06              BB.bat:num_fas
## 100  7.031646e-06                  Age.bat:G
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## 193  7.011375e-06               AB:BB.pitch
## 302  6.864000e-06                   X2B:BF
## 238  6.863565e-06      H.bat:W.L..same_year
## 1171 6.795634e-06                   SV:BF
## 182  6.754949e-06                   AB:SH
## 1059 6.671699e-06              Age.pitch:Ch
## 827  6.668008e-06                   TB:IP
## 1559 6.629882e-06            Ch:tot_fa_war3
## 922  6.616300e-06               HBP.bat:PO
## 294  6.469585e-06              X2B:H.pitch
## 784  6.429472e-06    OPSplus:W.L..same_year
## 1103 6.375598e-06                   GF:IP
## 1408 6.170384e-06                  BF:WHIP
## 551  6.116827e-06               BB.bat:Inn
## 598  6.071752e-06                SO.bat:PO
## 102  6.018245e-06               Age.bat:Ch
## 1093 5.898523e-06          W.L..same_year:A
## 460  5.877023e-06                   SB:PO
## 458  5.804836e-06                  SB:Inn
## 844  5.746076e-06                    TB:G
## 236  5.709596e-06            H.bat:IBB.bat
## 1570 5.643742e-06                     A:DP
## 1262 5.630031e-06              HR.pitch:Ch
## 173  5.431408e-06                AB:SO.bat
## 459  5.425877e-06                   SB:Ch
## 595  5.377272e-06                 SO.bat:G
## 185  5.345389e-06              AB:Age.pitch
## 788  5.297463e-06                OPSplus:IP
## 381  5.264939e-06                HR.bat:TB
## 311  5.262376e-06                  X2B:Inn
## 1237 4.950969e-06               H.pitch:PO
## 120  4.714264e-06                PA:SO.bat
## 243  4.683903e-06            H.bat:H.pitch
## 114  4.680892e-06                   PA:X2B
## 428  4.615786e-06               SB:OPSplus
## 282  4.567798e-06                   X2B:TB
## 167  4.496434e-06                   AB:X2B
## 1263 4.493888e-06              HR.pitch:PO
## 597  4.377631e-06                SO.bat:Ch
## 483  4.356128e-06         CS:W.L..same_year
## 476  4.339753e-06                   CS:TB
## 187  4.313883e-06                   AB:GF
## 567  4.272190e-06                SO.bat:TB
## 140  4.214985e-06              PA:BB.pitch
## 808  4.040089e-06               OPSplus:PO
## 186  4.034633e-06         AB:W.L..same_year
## 152  3.979724e-06                   PA:SO9
## 312  3.942710e-06                   X2B:Ch
## 231  3.935606e-06                  H.bat:TB
## 1226 3.927186e-06               H.pitch:BF
## 1252 3.857402e-06              HR.pitch:BF
## 313  3.853465e-06                   X2B:PO
## 956  3.806828e-06                   SH:Inn
## 1424 3.787415e-06            BF:tot_fa_war3
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## 1236 3.748494e-06                H.pitch:Ch
## 506  3.720675e-06                     CS:Ch
## 957  3.672007e-06                     SH:Ch
## 1335 3.655676e-06                SO.pitch:PO
## 1414 3.652951e-06                      BF:G
## 587  3.645147e-06                  SO.bat:BF
## 1121 3.613861e-06                     GF:Inn
## 854  3.558969e-06             TB:tot_fa_war3
## 1420 3.542763e-06                      BF:DP
## 1112 3.346548e-06                      GF:BF
## 1551 3.288046e-06                Inn:num_fas
## 224  3.258768e-06               H.bat:BB.bat
## 247  3.242100e-06              H.bat:SO.pitch
## 1539 3.240318e-06                     G:RF.G
## 178  3.214350e-06                AB:OPSplus
## 1550 3.195618e-06            Inn:tot_fa_war3
## 269  3.146338e-06           H.bat:tot_fa_war3
## 211  3.099196e-06                      AB:A
## 1534 3.030615e-06                       G:A
## 1207 2.991829e-06                      IP:G
## 848  2.926373e-06                      TB:A
## 191  2.912288e-06                AB:H.pitch
## 1334 2.898949e-06               SO.pitch:Ch
## 1123 2.885556e-06                     GF:PO
## 1210 2.854943e-06                     IP:PO
## 1546 2.810803e-06                    Inn:DP
## 934  2.778075e-06           SH:W.L..same_year
## 828  2.677027e-06                 TB:H.pitch
## 125  2.627111e-06                 PA:OPSplus
## 1333 2.557862e-06              SO.pitch:Inn
## 809  2.448871e-06                 OPSplus:A
## 850  2.396416e-06                     TB:DP
## 133  2.369969e-06           PA:W.L..same_year
## 807  2.350776e-06                 OPSplus:Ch
## 1561 2.340040e-06                      PO:A
## 1090 2.261078e-06          W.L..same_year:Inn
## 263  2.254257e-06                    H.bat:A
## 797  2.170408e-06                 OPSplus:BF
## 1199 2.122917e-06                     IP:BF
## 1209 2.114842e-06                     IP:Ch
## 1081 2.063179e-06           W.L..same_year:BF
## 1418 2.057561e-06                      BF:A
## 138  2.023815e-06                 PA:H.pitch
## 132  2.017155e-06               PA:Age.pitch
## 1277 1.922369e-06                BB.pitch:BF
## 207  1.872037e-06                       AB:G
## 262  1.768004e-06                  H.bat:PO
## 166  1.623697e-06                  AB:H.bat
## 158  1.597025e-06                      PA:A
## 113  1.571577e-06                  PA:H.bat
## 1235 1.501238e-06                H.pitch:Inn
## 1286 1.409044e-06               BB.pitch:Inn
## 195  1.391067e-06                AB:SO.pitch
## 210  1.314037e-06                      AB:PO
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## 1531 1.310547e-06                   G:Inn
## 101  1.252777e-06              Age.bat:Inn
## 1244 1.240290e-06       H.pitch:tot_fa_war3
## 164  1.187586e-06            PA:tot_fa_war3
## 1466 1.176162e-06                   H9:Inn
## 190  1.161333e-06                   AB:IP
## 261  1.155572e-06                  H.bat:Ch
## 1387 1.136975e-06                   WP:BF
## 836  1.105141e-06                   TB:BF
## 179  1.102041e-06                   AB:TB
## 902  1.098890e-06                HBP.bat:IP
## 242  1.061521e-06                  H.bat:IP
## 259  1.049159e-06                   H.bat:G
## 1092 1.036585e-06         W.L..same_year:PO
## 209  9.450452e-07                   AB:Ch
## 126  9.106880e-07                   PA:TB
## 921  8.931724e-07                HBP.bat:Ch
## 1417 8.396059e-07                   BF:PO
## 1288 8.292955e-07               BB.pitch:PO
## 1301 8.281366e-07               IBB.pitch:BF
## 507  7.984866e-07                   CS:PO
## 1553 7.664972e-07                    Ch:A
## 805  7.358009e-07                OPSplus:G
## 172  7.248114e-07                AB:BB.bat
## 157  7.194677e-07                   PA:PO
## 112  7.062113e-07                   PA:AB
## 1532 6.933734e-07                    G:Ch
## 1412 6.927583e-07                   BF:SO9
## 845  6.849328e-07                   TB:Inn
## 596  6.683880e-07                SO.bat:Inn
## 1416 6.562961e-07                   BF:Ch
## 1552 6.321030e-07                   Ch:PO
## 1533 6.040969e-07                    G:PO
## 119  6.010916e-07                PA:BB.bat
## 156  5.143191e-07                   PA:Ch
## 846  5.039799e-07                   TB:Ch
## 1415 4.995050e-07                   BF:Inn
## 217  4.948924e-07           AB:tot_fa_war3
## 199  4.878991e-07                   AB:BF
## 137  4.547387e-07                   PA:IP
## 154  4.517069e-07                    PA:G
## 134  4.177885e-07                   PA:GF
## 847  3.798531e-07                   TB:PO
## 1544 3.791806e-07                   Inn:A
## 1072 3.415013e-07         W.L..same_year:IP
## 1208 3.333706e-07                   IP:Inn
## 208  2.397006e-07                   AB:Inn
## 958  2.344555e-07                   SH:PO
## 146  2.266023e-07                   PA:BF
## 1122 2.228797e-07                   GF:Ch
## 1287 2.175015e-07               BB.pitch:Ch
## 1085 2.156021e-07        W.L..same_year:HR9
## 142  1.939659e-07               PA:SO.pitch
## 806  1.935018e-07               OPSplus:Inn
```

```
## 1549 1.933207e-07                  Inn:RF.G
## 1049 1.882002e-07               Age.pitch:BF
## 251  1.623269e-07                  H.bat:BF
## 777  1.020291e-07                OPSplus:TB
## 260  9.273948e-08                 H.bat:Inn
## 155  5.941068e-08                    PA:Inn
## 1543 2.981076e-08                    Inn:PO
## 1542 2.478082e-08                    Inn:Ch
## 1324 4.457187e-09                 SO.pitch:BF
## 1091 8.658471e-10          W.L..same_year:Ch
```

```
X.fullinteraction.test = model.matrix(lm.fullinteraction, data=test.df)[,-1] # drop intercept

yhats.fullinteraction.train = predict(ridges.fullinteraction, X.fullinteraction)
ridgesfullinteraction.trainRMSE = RMSE(train.df$W.L..next_year, yhats.fullinteraction.train) # train RM
ridgesfullinteraction.trainR2 = R2(train.df$W.L..next_year, yhats.fullinteraction.train) # train R2

yhats.fullinteraction.test = predict(ridges.fullinteraction, X.fullinteraction.test)
#plot(RMSE.ridges.fullinteraction.test~log(ridges.fullinteraction$lambda, 10), type='l')
ridgesfullinteraction.testRMSE = RMSE(test.df$W.L..next_year, yhats.fullinteraction.test) # train RMSE
ridgesfullinteraction.testR2 = R2(test.df$W.L..next_year, yhats.fullinteraction.test) # train R2
```

```
set.seed(139)
# Lasso Regression
# regularize full model

best_lambda = cv.glmnet(X.full, train.df$W.L..next_year, alpha=1,
                        lambda=10^seq(-4, 4, 0.1))$lambda.min; best_lambda
```

```
## [1] 0.1
```

```
lassos.full = glmnet(X.full, train.df$W.L..next_year, alpha=1,
                     lambda=best_lambda)
imp <- as.data.frame(varImp(lassos.full, lambda=best_lambda))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##         overall          names
## 13 51.346608876            OBP
## 14 15.747282283            SLG
## 39  9.118031416           WHIP
## 52  6.107874541           Fld.
## 26  2.900601071            SHO
## 35  2.127089776             BK
## 54  1.723965576           RF.G
## 40  1.458339471             H9
## 6   1.072349172            X3B
## 41  0.996277557            HR9
## 44  0.871669004           SO.W
## 50  0.689400177              E
## 1   0.653267204        Age.bat
```

```
## 21  0.627118263             SF
## 27  0.585180436             SV
## 18  0.402857852            GDP
## 23  0.299592145      Age.pitch
## 7   0.245143254         HR.bat
## 22  0.187070660        IBB.bat
## 30  0.186608614       HR.pitch
## 56  0.167126067        num_fas
## 10  0.153054474         BB.bat
## 36  0.139679543             WP
## 55  0.115685996    tot_fa_war3
## 19  0.099727307        HBP.bat
## 11  0.074414564         SO.bat
## 45  0.036769075              G
## 24  0.029004791 W.L..same_year
## 51  0.028072568             DP
## 3   0.006381508             AB
## 46  0.004913050            Inn
## 2   0.000000000             PA
## 4   0.000000000          H.bat
## 5   0.000000000            X2B
## 8   0.000000000             SB
## 9   0.000000000             CS
## 12  0.000000000             BA
## 15  0.000000000            OPS
## 16  0.000000000        OPSplus
## 17  0.000000000             TB
## 20  0.000000000             SH
## 25  0.000000000             GF
## 28  0.000000000             IP
## 29  0.000000000        H.pitch
## 31  0.000000000       BB.pitch
## 32  0.000000000      IBB.pitch
## 33  0.000000000       SO.pitch
## 34  0.000000000      HBP.pitch
## 37  0.000000000             BF
## 38  0.000000000            FIP
## 42  0.000000000            BB9
## 43  0.000000000            SO9
## 47  0.000000000             Ch
## 48  0.000000000             PO
## 49  0.000000000              A
## 53  0.000000000          RF.9
```

```
yhats.full.train = predict(lassos.full, X.full)
lassosfull.trainRMSE = RMSE(train.df$W.L..next_year, yhats.full.train) # train RMSE
lassosfull.trainR2 = R2(train.df$W.L..next_year, yhats.full.train) # train R2

yhats.full.test = predict(lassos.full, X.full.test)
#plot(RMSE.lassos.full.test~log(ridges.full$lambda, 10), type='l')
lassosfull.testRMSE = RMSE(test.df$W.L..next_year, yhats.full.test) # test RMSE
lassosfull.testR2 = R2(test.df$W.L..next_year, yhats.full.test) # test RMSE
```

```
set.seed(139)
# regularize full interaction model

best_lambda = cv.glmnet(X.fullinteraction, train.df$W.L..next_year, alpha=1,
                        lambda=10^seq(-4, 4, 0.1))$lambda.min; best_lambda
```

```
## [1] 0.1258925
```

```
lassos.fullinteraction = glmnet(X.fullinteraction, train.df$W.L..next_year, alpha=1,
                     lambda=best_lambda)
imp <- as.data.frame(varImp(lassos.fullinteraction, lambda=best_lambda))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##           overall                     names
## 689  4.480557e+01                  OBP:Fld.
## 731  1.264410e+01                  SLG:Fld.
## 13   7.770570e+00                       OBP
## 936  1.328679e+00                    SH:SHO
## 1299 7.980187e-01                IBB.pitch:BK
## 986  7.483075e-01                     SF:HR9
## 660  5.828154e-01               OBP:Age.pitch
## 1447 3.713172e-01                    WHIP:SO9
## 1458 2.711806e-01                   WHIP:RF.G
## 349  2.064814e-01               X3B:HBP.pitch
## 915  1.705253e-01                 HBP.bat:HR9
## 1155 1.417132e-01                       SHO:E
## 1366 1.322031e-01                       BK:WP
## 408  1.183323e-01                 HR.bat:SO.W
## 1176 1.085757e-01                      SV:BB9
## 1512 8.556463e-02                       SO9:E
## 95   6.342582e-02                  Age.bat:H9
## 109  4.873753e-02                 Age.bat:RF.G
## 1505 3.194645e-02                 BB9:num_fas
## 396  2.521769e-02           HR.bat:IBB.pitch
## 1529 2.263680e-02           SO.W:tot_fa_war3
## 1023 2.006565e-02               IBB.bat:SO.W
## 558  1.647033e-02                 BB.bat:RF.9
## 1319 9.670504e-03      IBB.pitch:tot_fa_war3
## 893  8.912518e-03                 GDP:num_fas
## 94   8.877656e-03                Age.bat:WHIP
## 1030 6.885960e-03                  IBB.bat:DP
## 532  6.791323e-03                   BB.bat:SV
## 1078 6.426697e-03   W.L..same_year:HBP.pitch
## 568  5.954769e-03                  SO.bat:GDP
## 326  5.867012e-03                  X3B:SO.bat
## 548  4.755749e-03                  BB.bat:SO9
## 1364 3.522950e-03      HBP.pitch:tot_fa_war3
## 1517 3.109734e-03            SO9:tot_fa_war3
## 1232 2.833312e-03                H.pitch:SO9
## 790  1.711173e-03           OPSplus:HR.pitch
```

```
## 515  1.325575e-03                CS:num_fas
## 601  1.248516e-03                 SO.bat:DP
## 796  6.888385e-04                OPSplus:WP
## 1094 6.464253e-04          W.L..same_year:E
## 1058 2.481349e-04             Age.pitch:Inn
## 1036 1.906659e-04   Age.pitch:W.L..same_year
## 1057 1.343846e-04               Age.pitch:G
## 606  1.268698e-04            SO.bat:num_fas
## 1535 2.680677e-05                       G:E
## 173  1.009649e-05                  AB:SO.bat
## 1545 6.195159e-06                      Inn:E
## 1    0.000000e+00                   Age.bat
## 2    0.000000e+00                        PA
## 3    0.000000e+00                        AB
## 4    0.000000e+00                     H.bat
## 5    0.000000e+00                       X2B
## 6    0.000000e+00                       X3B
## 7    0.000000e+00                    HR.bat
## 8    0.000000e+00                        SB
## 9    0.000000e+00                        CS
## 10   0.000000e+00                    BB.bat
## 11   0.000000e+00                    SO.bat
## 12   0.000000e+00                        BA
## 14   0.000000e+00                       SLG
## 15   0.000000e+00                       OPS
## 16   0.000000e+00                   OPSplus
## 17   0.000000e+00                        TB
## 18   0.000000e+00                       GDP
## 19   0.000000e+00                   HBP.bat
## 20   0.000000e+00                        SH
## 21   0.000000e+00                        SF
## 22   0.000000e+00                   IBB.bat
## 23   0.000000e+00                 Age.pitch
## 24   0.000000e+00             W.L..same_year
## 25   0.000000e+00                        GF
## 26   0.000000e+00                       SHO
## 27   0.000000e+00                        SV
## 28   0.000000e+00                        IP
## 29   0.000000e+00                   H.pitch
## 30   0.000000e+00                  HR.pitch
## 31   0.000000e+00                  BB.pitch
## 32   0.000000e+00                 IBB.pitch
## 33   0.000000e+00                  SO.pitch
## 34   0.000000e+00                 HBP.pitch
## 35   0.000000e+00                        BK
## 36   0.000000e+00                        WP
## 37   0.000000e+00                        BF
## 38   0.000000e+00                       FIP
## 39   0.000000e+00                      WHIP
## 40   0.000000e+00                        H9
## 41   0.000000e+00                       HR9
## 42   0.000000e+00                       BB9
## 43   0.000000e+00                       SO9
## 44   0.000000e+00                      SO.W
```

```
## 45   0.000000e+00                       G
## 46   0.000000e+00                     Inn
## 47   0.000000e+00                      Ch
## 48   0.000000e+00                      PO
## 49   0.000000e+00                       A
## 50   0.000000e+00                       E
## 51   0.000000e+00                      DP
## 52   0.000000e+00                    Fld.
## 53   0.000000e+00                    RF.9
## 54   0.000000e+00                    RF.G
## 55   0.000000e+00              tot_fa_war3
## 56   0.000000e+00                  num_fas
## 57   0.000000e+00               Age.bat:PA
## 58   0.000000e+00               Age.bat:AB
## 59   0.000000e+00            Age.bat:H.bat
## 60   0.000000e+00              Age.bat:X2B
## 61   0.000000e+00              Age.bat:X3B
## 62   0.000000e+00            Age.bat:HR.bat
## 63   0.000000e+00               Age.bat:SB
## 64   0.000000e+00               Age.bat:CS
## 65   0.000000e+00            Age.bat:BB.bat
## 66   0.000000e+00            Age.bat:SO.bat
## 67   0.000000e+00               Age.bat:BA
## 68   0.000000e+00              Age.bat:OBP
## 69   0.000000e+00              Age.bat:SLG
## 70   0.000000e+00              Age.bat:OPS
## 71   0.000000e+00          Age.bat:OPSplus
## 72   0.000000e+00               Age.bat:TB
## 73   0.000000e+00              Age.bat:GDP
## 74   0.000000e+00          Age.bat:HBP.bat
## 75   0.000000e+00               Age.bat:SH
## 76   0.000000e+00               Age.bat:SF
## 77   0.000000e+00          Age.bat:IBB.bat
## 78   0.000000e+00       Age.bat:Age.pitch
## 79   0.000000e+00  Age.bat:W.L..same_year
## 80   0.000000e+00               Age.bat:GF
## 81   0.000000e+00              Age.bat:SHO
## 82   0.000000e+00               Age.bat:SV
## 83   0.000000e+00               Age.bat:IP
## 84   0.000000e+00          Age.bat:H.pitch
## 85   0.000000e+00         Age.bat:HR.pitch
## 86   0.000000e+00         Age.bat:BB.pitch
## 87   0.000000e+00        Age.bat:IBB.pitch
## 88   0.000000e+00         Age.bat:SO.pitch
## 89   0.000000e+00        Age.bat:HBP.pitch
## 90   0.000000e+00               Age.bat:BK
## 91   0.000000e+00               Age.bat:WP
## 92   0.000000e+00               Age.bat:BF
## 93   0.000000e+00              Age.bat:FIP
## 96   0.000000e+00              Age.bat:HR9
## 97   0.000000e+00              Age.bat:BB9
## 98   0.000000e+00              Age.bat:SO9
## 99   0.000000e+00             Age.bat:SO.W
## 100  0.000000e+00                Age.bat:G
```

```
## 101  0.000000e+00                Age.bat:Inn
## 102  0.000000e+00                 Age.bat:Ch
## 103  0.000000e+00                 Age.bat:PO
## 104  0.000000e+00                  Age.bat:A
## 105  0.000000e+00                  Age.bat:E
## 106  0.000000e+00                 Age.bat:DP
## 107  0.000000e+00               Age.bat:Fld.
## 108  0.000000e+00               Age.bat:RF.9
## 110  0.000000e+00        Age.bat:tot_fa_war3
## 111  0.000000e+00            Age.bat:num_fas
## 112  0.000000e+00                     PA:AB
## 113  0.000000e+00                  PA:H.bat
## 114  0.000000e+00                    PA:X2B
## 115  0.000000e+00                    PA:X3B
## 116  0.000000e+00                  PA:HR.bat
## 117  0.000000e+00                     PA:SB
## 118  0.000000e+00                     PA:CS
## 119  0.000000e+00                  PA:BB.bat
## 120  0.000000e+00                  PA:SO.bat
## 121  0.000000e+00                     PA:BA
## 122  0.000000e+00                    PA:OBP
## 123  0.000000e+00                    PA:SLG
## 124  0.000000e+00                    PA:OPS
## 125  0.000000e+00                 PA:OPSplus
## 126  0.000000e+00                     PA:TB
## 127  0.000000e+00                    PA:GDP
## 128  0.000000e+00                 PA:HBP.bat
## 129  0.000000e+00                     PA:SH
## 130  0.000000e+00                     PA:SF
## 131  0.000000e+00                 PA:IBB.bat
## 132  0.000000e+00              PA:Age.pitch
## 133  0.000000e+00          PA:W.L..same_year
## 134  0.000000e+00                     PA:GF
## 135  0.000000e+00                    PA:SHO
## 136  0.000000e+00                     PA:SV
## 137  0.000000e+00                     PA:IP
## 138  0.000000e+00                  PA:H.pitch
## 139  0.000000e+00                 PA:HR.pitch
## 140  0.000000e+00                 PA:BB.pitch
## 141  0.000000e+00                PA:IBB.pitch
## 142  0.000000e+00                 PA:SO.pitch
## 143  0.000000e+00                PA:HBP.pitch
## 144  0.000000e+00                     PA:BK
## 145  0.000000e+00                     PA:WP
## 146  0.000000e+00                     PA:BF
## 147  0.000000e+00                    PA:FIP
## 148  0.000000e+00                   PA:WHIP
## 149  0.000000e+00                     PA:H9
## 150  0.000000e+00                    PA:HR9
## 151  0.000000e+00                    PA:BB9
## 152  0.000000e+00                    PA:SO9
## 153  0.000000e+00                   PA:SO.W
## 154  0.000000e+00                      PA:G
## 155  0.000000e+00                    PA:Inn
```

```
## 156  0.000000e+00                  PA:Ch
## 157  0.000000e+00                  PA:PO
## 158  0.000000e+00                   PA:A
## 159  0.000000e+00                   PA:E
## 160  0.000000e+00                  PA:DP
## 161  0.000000e+00                 PA:Fld.
## 162  0.000000e+00                 PA:RF.9
## 163  0.000000e+00                 PA:RF.G
## 164  0.000000e+00           PA:tot_fa_war3
## 165  0.000000e+00               PA:num_fas
## 166  0.000000e+00                 AB:H.bat
## 167  0.000000e+00                   AB:X2B
## 168  0.000000e+00                   AB:X3B
## 169  0.000000e+00                AB:HR.bat
## 170  0.000000e+00                    AB:SB
## 171  0.000000e+00                    AB:CS
## 172  0.000000e+00                AB:BB.bat
## 174  0.000000e+00                    AB:BA
## 175  0.000000e+00                   AB:OBP
## 176  0.000000e+00                   AB:SLG
## 177  0.000000e+00                   AB:OPS
## 178  0.000000e+00               AB:OPSplus
## 179  0.000000e+00                    AB:TB
## 180  0.000000e+00                   AB:GDP
## 181  0.000000e+00               AB:HBP.bat
## 182  0.000000e+00                    AB:SH
## 183  0.000000e+00                    AB:SF
## 184  0.000000e+00               AB:IBB.bat
## 185  0.000000e+00            AB:Age.pitch
## 186  0.000000e+00         AB:W.L..same_year
## 187  0.000000e+00                    AB:GF
## 188  0.000000e+00                   AB:SHO
## 189  0.000000e+00                    AB:SV
## 190  0.000000e+00                    AB:IP
## 191  0.000000e+00                AB:H.pitch
## 192  0.000000e+00               AB:HR.pitch
## 193  0.000000e+00               AB:BB.pitch
## 194  0.000000e+00              AB:IBB.pitch
## 195  0.000000e+00               AB:SO.pitch
## 196  0.000000e+00              AB:HBP.pitch
## 197  0.000000e+00                    AB:BK
## 198  0.000000e+00                    AB:WP
## 199  0.000000e+00                    AB:BF
## 200  0.000000e+00                   AB:FIP
## 201  0.000000e+00                  AB:WHIP
## 202  0.000000e+00                    AB:H9
## 203  0.000000e+00                   AB:HR9
## 204  0.000000e+00                   AB:BB9
## 205  0.000000e+00                   AB:SO9
## 206  0.000000e+00                  AB:SO.W
## 207  0.000000e+00                     AB:G
## 208  0.000000e+00                   AB:Inn
## 209  0.000000e+00                    AB:Ch
## 210  0.000000e+00                    AB:PO
```

```
## 211  0.000000e+00                    AB:A
## 212  0.000000e+00                    AB:E
## 213  0.000000e+00                   AB:DP
## 214  0.000000e+00                  AB:Fld.
## 215  0.000000e+00                   AB:RF.9
## 216  0.000000e+00                   AB:RF.G
## 217  0.000000e+00            AB:tot_fa_war3
## 218  0.000000e+00                AB:num_fas
## 219  0.000000e+00                 H.bat:X2B
## 220  0.000000e+00                 H.bat:X3B
## 221  0.000000e+00              H.bat:HR.bat
## 222  0.000000e+00                  H.bat:SB
## 223  0.000000e+00                  H.bat:CS
## 224  0.000000e+00              H.bat:BB.bat
## 225  0.000000e+00              H.bat:SO.bat
## 226  0.000000e+00                  H.bat:BA
## 227  0.000000e+00                 H.bat:OBP
## 228  0.000000e+00                 H.bat:SLG
## 229  0.000000e+00                 H.bat:OPS
## 230  0.000000e+00             H.bat:OPSplus
## 231  0.000000e+00                  H.bat:TB
## 232  0.000000e+00                 H.bat:GDP
## 233  0.000000e+00              H.bat:HBP.bat
## 234  0.000000e+00                  H.bat:SH
## 235  0.000000e+00                  H.bat:SF
## 236  0.000000e+00              H.bat:IBB.bat
## 237  0.000000e+00           H.bat:Age.pitch
## 238  0.000000e+00      H.bat:W.L..same_year
## 239  0.000000e+00                  H.bat:GF
## 240  0.000000e+00                 H.bat:SHO
## 241  0.000000e+00                  H.bat:SV
## 242  0.000000e+00                  H.bat:IP
## 243  0.000000e+00             H.bat:H.pitch
## 244  0.000000e+00            H.bat:HR.pitch
## 245  0.000000e+00            H.bat:BB.pitch
## 246  0.000000e+00           H.bat:IBB.pitch
## 247  0.000000e+00            H.bat:SO.pitch
## 248  0.000000e+00           H.bat:HBP.pitch
## 249  0.000000e+00                  H.bat:BK
## 250  0.000000e+00                  H.bat:WP
## 251  0.000000e+00                  H.bat:BF
## 252  0.000000e+00                 H.bat:FIP
## 253  0.000000e+00                H.bat:WHIP
## 254  0.000000e+00                  H.bat:H9
## 255  0.000000e+00                 H.bat:HR9
## 256  0.000000e+00                 H.bat:BB9
## 257  0.000000e+00                 H.bat:SO9
## 258  0.000000e+00                H.bat:SO.W
## 259  0.000000e+00                   H.bat:G
## 260  0.000000e+00                 H.bat:Inn
## 261  0.000000e+00                  H.bat:Ch
## 262  0.000000e+00                  H.bat:PO
## 263  0.000000e+00                   H.bat:A
## 264  0.000000e+00                   H.bat:E
```

```
## 265  0.000000e+00                 H.bat:DP
## 266  0.000000e+00               H.bat:Fld.
## 267  0.000000e+00               H.bat:RF.9
## 268  0.000000e+00               H.bat:RF.G
## 269  0.000000e+00        H.bat:tot_fa_war3
## 270  0.000000e+00            H.bat:num_fas
## 271  0.000000e+00                  X2B:X3B
## 272  0.000000e+00               X2B:HR.bat
## 273  0.000000e+00                   X2B:SB
## 274  0.000000e+00                   X2B:CS
## 275  0.000000e+00               X2B:BB.bat
## 276  0.000000e+00               X2B:SO.bat
## 277  0.000000e+00                   X2B:BA
## 278  0.000000e+00                  X2B:OBP
## 279  0.000000e+00                  X2B:SLG
## 280  0.000000e+00                  X2B:OPS
## 281  0.000000e+00              X2B:OPSplus
## 282  0.000000e+00                   X2B:TB
## 283  0.000000e+00                  X2B:GDP
## 284  0.000000e+00              X2B:HBP.bat
## 285  0.000000e+00                   X2B:SH
## 286  0.000000e+00                   X2B:SF
## 287  0.000000e+00              X2B:IBB.bat
## 288  0.000000e+00           X2B:Age.pitch
## 289  0.000000e+00       X2B:W.L..same_year
## 290  0.000000e+00                   X2B:GF
## 291  0.000000e+00                  X2B:SHO
## 292  0.000000e+00                   X2B:SV
## 293  0.000000e+00                   X2B:IP
## 294  0.000000e+00              X2B:H.pitch
## 295  0.000000e+00             X2B:HR.pitch
## 296  0.000000e+00             X2B:BB.pitch
## 297  0.000000e+00            X2B:IBB.pitch
## 298  0.000000e+00             X2B:SO.pitch
## 299  0.000000e+00            X2B:HBP.pitch
## 300  0.000000e+00                   X2B:BK
## 301  0.000000e+00                   X2B:WP
## 302  0.000000e+00                   X2B:BF
## 303  0.000000e+00                  X2B:FIP
## 304  0.000000e+00                 X2B:WHIP
## 305  0.000000e+00                   X2B:H9
## 306  0.000000e+00                  X2B:HR9
## 307  0.000000e+00                  X2B:BB9
## 308  0.000000e+00                  X2B:SO9
## 309  0.000000e+00                 X2B:SO.W
## 310  0.000000e+00                    X2B:G
## 311  0.000000e+00                  X2B:Inn
## 312  0.000000e+00                   X2B:Ch
## 313  0.000000e+00                   X2B:PO
## 314  0.000000e+00                    X2B:A
## 315  0.000000e+00                    X2B:E
## 316  0.000000e+00                   X2B:DP
## 317  0.000000e+00                 X2B:Fld.
## 318  0.000000e+00                 X2B:RF.9
```

```
## 319  0.000000e+00                X2B:RF.G
## 320  0.000000e+00           X2B:tot_fa_war3
## 321  0.000000e+00               X2B:num_fas
## 322  0.000000e+00                X3B:HR.bat
## 323  0.000000e+00                    X3B:SB
## 324  0.000000e+00                    X3B:CS
## 325  0.000000e+00                X3B:BB.bat
## 327  0.000000e+00                    X3B:BA
## 328  0.000000e+00                   X3B:OBP
## 329  0.000000e+00                   X3B:SLG
## 330  0.000000e+00                   X3B:OPS
## 331  0.000000e+00                X3B:OPSplus
## 332  0.000000e+00                    X3B:TB
## 333  0.000000e+00                   X3B:GDP
## 334  0.000000e+00                X3B:HBP.bat
## 335  0.000000e+00                    X3B:SH
## 336  0.000000e+00                    X3B:SF
## 337  0.000000e+00                X3B:IBB.bat
## 338  0.000000e+00             X3B:Age.pitch
## 339  0.000000e+00        X3B:W.L..same_year
## 340  0.000000e+00                    X3B:GF
## 341  0.000000e+00                   X3B:SHO
## 342  0.000000e+00                    X3B:SV
## 343  0.000000e+00                    X3B:IP
## 344  0.000000e+00              X3B:H.pitch
## 345  0.000000e+00             X3B:HR.pitch
## 346  0.000000e+00             X3B:BB.pitch
## 347  0.000000e+00            X3B:IBB.pitch
## 348  0.000000e+00             X3B:SO.pitch
## 350  0.000000e+00                    X3B:BK
## 351  0.000000e+00                    X3B:WP
## 352  0.000000e+00                    X3B:BF
## 353  0.000000e+00                   X3B:FIP
## 354  0.000000e+00                  X3B:WHIP
## 355  0.000000e+00                    X3B:H9
## 356  0.000000e+00                   X3B:HR9
## 357  0.000000e+00                   X3B:BB9
## 358  0.000000e+00                   X3B:SO9
## 359  0.000000e+00                  X3B:SO.W
## 360  0.000000e+00                     X3B:G
## 361  0.000000e+00                   X3B:Inn
## 362  0.000000e+00                    X3B:Ch
## 363  0.000000e+00                    X3B:PO
## 364  0.000000e+00                     X3B:A
## 365  0.000000e+00                     X3B:E
## 366  0.000000e+00                    X3B:DP
## 367  0.000000e+00                  X3B:Fld.
## 368  0.000000e+00                  X3B:RF.9
## 369  0.000000e+00                  X3B:RF.G
## 370  0.000000e+00           X3B:tot_fa_war3
## 371  0.000000e+00               X3B:num_fas
## 372  0.000000e+00                 HR.bat:SB
## 373  0.000000e+00                 HR.bat:CS
## 374  0.000000e+00             HR.bat:BB.bat
```

```
## 375  0.000000e+00              HR.bat:SO.bat
## 376  0.000000e+00                   HR.bat:BA
## 377  0.000000e+00                  HR.bat:OBP
## 378  0.000000e+00                  HR.bat:SLG
## 379  0.000000e+00                  HR.bat:OPS
## 380  0.000000e+00             HR.bat:OPSplus
## 381  0.000000e+00                   HR.bat:TB
## 382  0.000000e+00                  HR.bat:GDP
## 383  0.000000e+00             HR.bat:HBP.bat
## 384  0.000000e+00                   HR.bat:SH
## 385  0.000000e+00                   HR.bat:SF
## 386  0.000000e+00             HR.bat:IBB.bat
## 387  0.000000e+00           HR.bat:Age.pitch
## 388  0.000000e+00      HR.bat:W.L..same_year
## 389  0.000000e+00                   HR.bat:GF
## 390  0.000000e+00                  HR.bat:SHO
## 391  0.000000e+00                   HR.bat:SV
## 392  0.000000e+00                   HR.bat:IP
## 393  0.000000e+00             HR.bat:H.pitch
## 394  0.000000e+00            HR.bat:HR.pitch
## 395  0.000000e+00            HR.bat:BB.pitch
## 397  0.000000e+00            HR.bat:SO.pitch
## 398  0.000000e+00           HR.bat:HBP.pitch
## 399  0.000000e+00                   HR.bat:BK
## 400  0.000000e+00                   HR.bat:WP
## 401  0.000000e+00                   HR.bat:BF
## 402  0.000000e+00                  HR.bat:FIP
## 403  0.000000e+00                 HR.bat:WHIP
## 404  0.000000e+00                   HR.bat:H9
## 405  0.000000e+00                  HR.bat:HR9
## 406  0.000000e+00                  HR.bat:BB9
## 407  0.000000e+00                  HR.bat:SO9
## 409  0.000000e+00                    HR.bat:G
## 410  0.000000e+00                  HR.bat:Inn
## 411  0.000000e+00                   HR.bat:Ch
## 412  0.000000e+00                   HR.bat:PO
## 413  0.000000e+00                    HR.bat:A
## 414  0.000000e+00                    HR.bat:E
## 415  0.000000e+00                   HR.bat:DP
## 416  0.000000e+00                 HR.bat:Fld.
## 417  0.000000e+00                 HR.bat:RF.9
## 418  0.000000e+00                 HR.bat:RF.G
## 419  0.000000e+00          HR.bat:tot_fa_war3
## 420  0.000000e+00              HR.bat:num_fas
## 421  0.000000e+00                       SB:CS
## 422  0.000000e+00                  SB:BB.bat
## 423  0.000000e+00                  SB:SO.bat
## 424  0.000000e+00                      SB:BA
## 425  0.000000e+00                     SB:OBP
## 426  0.000000e+00                     SB:SLG
## 427  0.000000e+00                     SB:OPS
## 428  0.000000e+00                  SB:OPSplus
## 429  0.000000e+00                       SB:TB
## 430  0.000000e+00                     SB:GDP
```

```
## 431  0.000000e+00                SB:HBP.bat
## 432  0.000000e+00                     SB:SH
## 433  0.000000e+00                     SB:SF
## 434  0.000000e+00                SB:IBB.bat
## 435  0.000000e+00             SB:Age.pitch
## 436  0.000000e+00          SB:W.L..same_year
## 437  0.000000e+00                     SB:GF
## 438  0.000000e+00                    SB:SHO
## 439  0.000000e+00                     SB:SV
## 440  0.000000e+00                     SB:IP
## 441  0.000000e+00                SB:H.pitch
## 442  0.000000e+00               SB:HR.pitch
## 443  0.000000e+00               SB:BB.pitch
## 444  0.000000e+00              SB:IBB.pitch
## 445  0.000000e+00               SB:SO.pitch
## 446  0.000000e+00              SB:HBP.pitch
## 447  0.000000e+00                     SB:BK
## 448  0.000000e+00                     SB:WP
## 449  0.000000e+00                     SB:BF
## 450  0.000000e+00                    SB:FIP
## 451  0.000000e+00                   SB:WHIP
## 452  0.000000e+00                     SB:H9
## 453  0.000000e+00                    SB:HR9
## 454  0.000000e+00                    SB:BB9
## 455  0.000000e+00                    SB:SO9
## 456  0.000000e+00                   SB:SO.W
## 457  0.000000e+00                      SB:G
## 458  0.000000e+00                    SB:Inn
## 459  0.000000e+00                     SB:Ch
## 460  0.000000e+00                     SB:PO
## 461  0.000000e+00                      SB:A
## 462  0.000000e+00                      SB:E
## 463  0.000000e+00                     SB:DP
## 464  0.000000e+00                   SB:Fld.
## 465  0.000000e+00                   SB:RF.9
## 466  0.000000e+00                   SB:RF.G
## 467  0.000000e+00             SB:tot_fa_war3
## 468  0.000000e+00                 SB:num_fas
## 469  0.000000e+00                  CS:BB.bat
## 470  0.000000e+00                  CS:SO.bat
## 471  0.000000e+00                      CS:BA
## 472  0.000000e+00                     CS:OBP
## 473  0.000000e+00                     CS:SLG
## 474  0.000000e+00                     CS:OPS
## 475  0.000000e+00                CS:OPSplus
## 476  0.000000e+00                      CS:TB
## 477  0.000000e+00                     CS:GDP
## 478  0.000000e+00                CS:HBP.bat
## 479  0.000000e+00                     CS:SH
## 480  0.000000e+00                     CS:SF
## 481  0.000000e+00                CS:IBB.bat
## 482  0.000000e+00             CS:Age.pitch
## 483  0.000000e+00          CS:W.L..same_year
## 484  0.000000e+00                     CS:GF
```

```
## 485  0.000000e+00                  CS:SHO
## 486  0.000000e+00                   CS:SV
## 487  0.000000e+00                   CS:IP
## 488  0.000000e+00                CS:H.pitch
## 489  0.000000e+00               CS:HR.pitch
## 490  0.000000e+00               CS:BB.pitch
## 491  0.000000e+00              CS:IBB.pitch
## 492  0.000000e+00               CS:SO.pitch
## 493  0.000000e+00              CS:HBP.pitch
## 494  0.000000e+00                      CS:BK
## 495  0.000000e+00                      CS:WP
## 496  0.000000e+00                      CS:BF
## 497  0.000000e+00                     CS:FIP
## 498  0.000000e+00                    CS:WHIP
## 499  0.000000e+00                      CS:H9
## 500  0.000000e+00                     CS:HR9
## 501  0.000000e+00                     CS:BB9
## 502  0.000000e+00                     CS:SO9
## 503  0.000000e+00                    CS:SO.W
## 504  0.000000e+00                       CS:G
## 505  0.000000e+00                     CS:Inn
## 506  0.000000e+00                      CS:Ch
## 507  0.000000e+00                      CS:PO
## 508  0.000000e+00                       CS:A
## 509  0.000000e+00                       CS:E
## 510  0.000000e+00                      CS:DP
## 511  0.000000e+00                    CS:Fld.
## 512  0.000000e+00                    CS:RF.9
## 513  0.000000e+00                    CS:RF.G
## 514  0.000000e+00             CS:tot_fa_war3
## 516  0.000000e+00              BB.bat:SO.bat
## 517  0.000000e+00                  BB.bat:BA
## 518  0.000000e+00                 BB.bat:OBP
## 519  0.000000e+00                 BB.bat:SLG
## 520  0.000000e+00                 BB.bat:OPS
## 521  0.000000e+00             BB.bat:OPSplus
## 522  0.000000e+00                  BB.bat:TB
## 523  0.000000e+00                 BB.bat:GDP
## 524  0.000000e+00             BB.bat:HBP.bat
## 525  0.000000e+00                  BB.bat:SH
## 526  0.000000e+00                  BB.bat:SF
## 527  0.000000e+00             BB.bat:IBB.bat
## 528  0.000000e+00          BB.bat:Age.pitch
## 529  0.000000e+00      BB.bat:W.L..same_year
## 530  0.000000e+00                  BB.bat:GF
## 531  0.000000e+00                BB.bat:SHO
## 533  0.000000e+00                  BB.bat:IP
## 534  0.000000e+00             BB.bat:H.pitch
## 535  0.000000e+00            BB.bat:HR.pitch
## 536  0.000000e+00            BB.bat:BB.pitch
## 537  0.000000e+00           BB.bat:IBB.pitch
## 538  0.000000e+00            BB.bat:SO.pitch
## 539  0.000000e+00           BB.bat:HBP.pitch
## 540  0.000000e+00                  BB.bat:BK
```

```
## 541  0.000000e+00                BB.bat:WP
## 542  0.000000e+00                BB.bat:BF
## 543  0.000000e+00               BB.bat:FIP
## 544  0.000000e+00              BB.bat:WHIP
## 545  0.000000e+00                BB.bat:H9
## 546  0.000000e+00               BB.bat:HR9
## 547  0.000000e+00               BB.bat:BB9
## 549  0.000000e+00              BB.bat:SO.W
## 550  0.000000e+00                 BB.bat:G
## 551  0.000000e+00               BB.bat:Inn
## 552  0.000000e+00                BB.bat:Ch
## 553  0.000000e+00                BB.bat:PO
## 554  0.000000e+00                 BB.bat:A
## 555  0.000000e+00                 BB.bat:E
## 556  0.000000e+00                BB.bat:DP
## 557  0.000000e+00              BB.bat:Fld.
## 559  0.000000e+00              BB.bat:RF.G
## 560  0.000000e+00       BB.bat:tot_fa_war3
## 561  0.000000e+00           BB.bat:num_fas
## 562  0.000000e+00                SO.bat:BA
## 563  0.000000e+00               SO.bat:OBP
## 564  0.000000e+00               SO.bat:SLG
## 565  0.000000e+00               SO.bat:OPS
## 566  0.000000e+00           SO.bat:OPSplus
## 567  0.000000e+00                SO.bat:TB
## 569  0.000000e+00           SO.bat:HBP.bat
## 570  0.000000e+00                SO.bat:SH
## 571  0.000000e+00                SO.bat:SF
## 572  0.000000e+00           SO.bat:IBB.bat
## 573  0.000000e+00         SO.bat:Age.pitch
## 574  0.000000e+00    SO.bat:W.L..same_year
## 575  0.000000e+00                SO.bat:GF
## 576  0.000000e+00               SO.bat:SHO
## 577  0.000000e+00                SO.bat:SV
## 578  0.000000e+00                SO.bat:IP
## 579  0.000000e+00           SO.bat:H.pitch
## 580  0.000000e+00          SO.bat:HR.pitch
## 581  0.000000e+00          SO.bat:BB.pitch
## 582  0.000000e+00         SO.bat:IBB.pitch
## 583  0.000000e+00          SO.bat:SO.pitch
## 584  0.000000e+00         SO.bat:HBP.pitch
## 585  0.000000e+00                SO.bat:BK
## 586  0.000000e+00                SO.bat:WP
## 587  0.000000e+00                SO.bat:BF
## 588  0.000000e+00               SO.bat:FIP
## 589  0.000000e+00              SO.bat:WHIP
## 590  0.000000e+00                SO.bat:H9
## 591  0.000000e+00               SO.bat:HR9
## 592  0.000000e+00               SO.bat:BB9
## 593  0.000000e+00               SO.bat:SO9
## 594  0.000000e+00              SO.bat:SO.W
## 595  0.000000e+00                 SO.bat:G
## 596  0.000000e+00               SO.bat:Inn
## 597  0.000000e+00                SO.bat:Ch
```

```
## 598  0.000000e+00                 SO.bat:PO
## 599  0.000000e+00                  SO.bat:A
## 600  0.000000e+00                  SO.bat:E
## 602  0.000000e+00               SO.bat:Fld.
## 603  0.000000e+00               SO.bat:RF.9
## 604  0.000000e+00               SO.bat:RF.G
## 605  0.000000e+00        SO.bat:tot_fa_war3
## 607  0.000000e+00                   BA:OBP
## 608  0.000000e+00                   BA:SLG
## 609  0.000000e+00                   BA:OPS
## 610  0.000000e+00                BA:OPSplus
## 611  0.000000e+00                    BA:TB
## 612  0.000000e+00                   BA:GDP
## 613  0.000000e+00                BA:HBP.bat
## 614  0.000000e+00                    BA:SH
## 615  0.000000e+00                    BA:SF
## 616  0.000000e+00                BA:IBB.bat
## 617  0.000000e+00             BA:Age.pitch
## 618  0.000000e+00         BA:W.L..same_year
## 619  0.000000e+00                   BA:GF
## 620  0.000000e+00                  BA:SHO
## 621  0.000000e+00                   BA:SV
## 622  0.000000e+00                   BA:IP
## 623  0.000000e+00                BA:H.pitch
## 624  0.000000e+00               BA:HR.pitch
## 625  0.000000e+00               BA:BB.pitch
## 626  0.000000e+00              BA:IBB.pitch
## 627  0.000000e+00               BA:SO.pitch
## 628  0.000000e+00              BA:HBP.pitch
## 629  0.000000e+00                    BA:BK
## 630  0.000000e+00                    BA:WP
## 631  0.000000e+00                    BA:BF
## 632  0.000000e+00                   BA:FIP
## 633  0.000000e+00                  BA:WHIP
## 634  0.000000e+00                    BA:H9
## 635  0.000000e+00                   BA:HR9
## 636  0.000000e+00                   BA:BB9
## 637  0.000000e+00                   BA:SO9
## 638  0.000000e+00                  BA:SO.W
## 639  0.000000e+00                     BA:G
## 640  0.000000e+00                   BA:Inn
## 641  0.000000e+00                    BA:Ch
## 642  0.000000e+00                    BA:PO
## 643  0.000000e+00                     BA:A
## 644  0.000000e+00                     BA:E
## 645  0.000000e+00                    BA:DP
## 646  0.000000e+00                  BA:Fld.
## 647  0.000000e+00                  BA:RF.9
## 648  0.000000e+00                  BA:RF.G
## 649  0.000000e+00             BA:tot_fa_war3
## 650  0.000000e+00                 BA:num_fas
## 651  0.000000e+00                    OBP:SLG
## 652  0.000000e+00                    OBP:OPS
## 653  0.000000e+00                 OBP:OPSplus
```

```
## 654  0.000000e+00                  OBP:TB
## 655  0.000000e+00                 OBP:GDP
## 656  0.000000e+00              OBP:HBP.bat
## 657  0.000000e+00                  OBP:SH
## 658  0.000000e+00                  OBP:SF
## 659  0.000000e+00              OBP:IBB.bat
## 661  0.000000e+00       OBP:W.L..same_year
## 662  0.000000e+00                  OBP:GF
## 663  0.000000e+00                 OBP:SHO
## 664  0.000000e+00                  OBP:SV
## 665  0.000000e+00                  OBP:IP
## 666  0.000000e+00              OBP:H.pitch
## 667  0.000000e+00             OBP:HR.pitch
## 668  0.000000e+00             OBP:BB.pitch
## 669  0.000000e+00            OBP:IBB.pitch
## 670  0.000000e+00             OBP:SO.pitch
## 671  0.000000e+00            OBP:HBP.pitch
## 672  0.000000e+00                  OBP:BK
## 673  0.000000e+00                  OBP:WP
## 674  0.000000e+00                  OBP:BF
## 675  0.000000e+00                 OBP:FIP
## 676  0.000000e+00                OBP:WHIP
## 677  0.000000e+00                  OBP:H9
## 678  0.000000e+00                 OBP:HR9
## 679  0.000000e+00                 OBP:BB9
## 680  0.000000e+00                 OBP:SO9
## 681  0.000000e+00                OBP:SO.W
## 682  0.000000e+00                   OBP:G
## 683  0.000000e+00                 OBP:Inn
## 684  0.000000e+00                  OBP:Ch
## 685  0.000000e+00                  OBP:PO
## 686  0.000000e+00                   OBP:A
## 687  0.000000e+00                   OBP:E
## 688  0.000000e+00                  OBP:DP
## 690  0.000000e+00                OBP:RF.9
## 691  0.000000e+00                OBP:RF.G
## 692  0.000000e+00           OBP:tot_fa_war3
## 693  0.000000e+00               OBP:num_fas
## 694  0.000000e+00                   SLG:OPS
## 695  0.000000e+00              SLG:OPSplus
## 696  0.000000e+00                   SLG:TB
## 697  0.000000e+00                  SLG:GDP
## 698  0.000000e+00              SLG:HBP.bat
## 699  0.000000e+00                   SLG:SH
## 700  0.000000e+00                   SLG:SF
## 701  0.000000e+00              SLG:IBB.bat
## 702  0.000000e+00            SLG:Age.pitch
## 703  0.000000e+00       SLG:W.L..same_year
## 704  0.000000e+00                   SLG:GF
## 705  0.000000e+00                  SLG:SHO
## 706  0.000000e+00                   SLG:SV
## 707  0.000000e+00                   SLG:IP
## 708  0.000000e+00               SLG:H.pitch
## 709  0.000000e+00              SLG:HR.pitch
```

```
## 710  0.000000e+00              SLG:BB.pitch
## 711  0.000000e+00             SLG:IBB.pitch
## 712  0.000000e+00              SLG:SO.pitch
## 713  0.000000e+00             SLG:HBP.pitch
## 714  0.000000e+00                    SLG:BK
## 715  0.000000e+00                    SLG:WP
## 716  0.000000e+00                    SLG:BF
## 717  0.000000e+00                   SLG:FIP
## 718  0.000000e+00                  SLG:WHIP
## 719  0.000000e+00                    SLG:H9
## 720  0.000000e+00                   SLG:HR9
## 721  0.000000e+00                   SLG:BB9
## 722  0.000000e+00                   SLG:SO9
## 723  0.000000e+00                  SLG:SO.W
## 724  0.000000e+00                     SLG:G
## 725  0.000000e+00                   SLG:Inn
## 726  0.000000e+00                    SLG:Ch
## 727  0.000000e+00                    SLG:PO
## 728  0.000000e+00                     SLG:A
## 729  0.000000e+00                     SLG:E
## 730  0.000000e+00                    SLG:DP
## 732  0.000000e+00                  SLG:RF.9
## 733  0.000000e+00                  SLG:RF.G
## 734  0.000000e+00           SLG:tot_fa_war3
## 735  0.000000e+00               SLG:num_fas
## 736  0.000000e+00               OPS:OPSplus
## 737  0.000000e+00                    OPS:TB
## 738  0.000000e+00                   OPS:GDP
## 739  0.000000e+00               OPS:HBP.bat
## 740  0.000000e+00                    OPS:SH
## 741  0.000000e+00                    OPS:SF
## 742  0.000000e+00               OPS:IBB.bat
## 743  0.000000e+00             OPS:Age.pitch
## 744  0.000000e+00        OPS:W.L..same_year
## 745  0.000000e+00                    OPS:GF
## 746  0.000000e+00                   OPS:SHO
## 747  0.000000e+00                    OPS:SV
## 748  0.000000e+00                    OPS:IP
## 749  0.000000e+00              OPS:H.pitch
## 750  0.000000e+00             OPS:HR.pitch
## 751  0.000000e+00             OPS:BB.pitch
## 752  0.000000e+00            OPS:IBB.pitch
## 753  0.000000e+00             OPS:SO.pitch
## 754  0.000000e+00            OPS:HBP.pitch
## 755  0.000000e+00                    OPS:BK
## 756  0.000000e+00                    OPS:WP
## 757  0.000000e+00                    OPS:BF
## 758  0.000000e+00                   OPS:FIP
## 759  0.000000e+00                  OPS:WHIP
## 760  0.000000e+00                    OPS:H9
## 761  0.000000e+00                   OPS:HR9
## 762  0.000000e+00                   OPS:BB9
## 763  0.000000e+00                   OPS:SO9
## 764  0.000000e+00                  OPS:SO.W
```

```
## 765  0.000000e+00                   OPS:G
## 766  0.000000e+00                 OPS:Inn
## 767  0.000000e+00                  OPS:Ch
## 768  0.000000e+00                  OPS:PO
## 769  0.000000e+00                   OPS:A
## 770  0.000000e+00                   OPS:E
## 771  0.000000e+00                  OPS:DP
## 772  0.000000e+00                OPS:Fld.
## 773  0.000000e+00                OPS:RF.9
## 774  0.000000e+00                OPS:RF.G
## 775  0.000000e+00           OPS:tot_fa_war3
## 776  0.000000e+00               OPS:num_fas
## 777  0.000000e+00               OPSplus:TB
## 778  0.000000e+00             OPSplus:GDP
## 779  0.000000e+00          OPSplus:HBP.bat
## 780  0.000000e+00               OPSplus:SH
## 781  0.000000e+00               OPSplus:SF
## 782  0.000000e+00          OPSplus:IBB.bat
## 783  0.000000e+00        OPSplus:Age.pitch
## 784  0.000000e+00    OPSplus:W.L..same_year
## 785  0.000000e+00               OPSplus:GF
## 786  0.000000e+00             OPSplus:SHO
## 787  0.000000e+00               OPSplus:SV
## 788  0.000000e+00               OPSplus:IP
## 789  0.000000e+00          OPSplus:H.pitch
## 791  0.000000e+00         OPSplus:BB.pitch
## 792  0.000000e+00        OPSplus:IBB.pitch
## 793  0.000000e+00         OPSplus:SO.pitch
## 794  0.000000e+00        OPSplus:HBP.pitch
## 795  0.000000e+00               OPSplus:BK
## 797  0.000000e+00               OPSplus:BF
## 798  0.000000e+00              OPSplus:FIP
## 799  0.000000e+00             OPSplus:WHIP
## 800  0.000000e+00               OPSplus:H9
## 801  0.000000e+00              OPSplus:HR9
## 802  0.000000e+00              OPSplus:BB9
## 803  0.000000e+00              OPSplus:SO9
## 804  0.000000e+00             OPSplus:SO.W
## 805  0.000000e+00                OPSplus:G
## 806  0.000000e+00              OPSplus:Inn
## 807  0.000000e+00               OPSplus:Ch
## 808  0.000000e+00               OPSplus:PO
## 809  0.000000e+00                OPSplus:A
## 810  0.000000e+00                OPSplus:E
## 811  0.000000e+00               OPSplus:DP
## 812  0.000000e+00             OPSplus:Fld.
## 813  0.000000e+00             OPSplus:RF.9
## 814  0.000000e+00             OPSplus:RF.G
## 815  0.000000e+00        OPSplus:tot_fa_war3
## 816  0.000000e+00            OPSplus:num_fas
## 817  0.000000e+00                    TB:GDP
## 818  0.000000e+00                 TB:HBP.bat
## 819  0.000000e+00                      TB:SH
## 820  0.000000e+00                      TB:SF
```

```
## 821  0.000000e+00                TB:IBB.bat
## 822  0.000000e+00              TB:Age.pitch
## 823  0.000000e+00         TB:W.L..same_year
## 824  0.000000e+00                     TB:GF
## 825  0.000000e+00                    TB:SHO
## 826  0.000000e+00                     TB:SV
## 827  0.000000e+00                     TB:IP
## 828  0.000000e+00                TB:H.pitch
## 829  0.000000e+00               TB:HR.pitch
## 830  0.000000e+00               TB:BB.pitch
## 831  0.000000e+00              TB:IBB.pitch
## 832  0.000000e+00               TB:SO.pitch
## 833  0.000000e+00              TB:HBP.pitch
## 834  0.000000e+00                     TB:BK
## 835  0.000000e+00                     TB:WP
## 836  0.000000e+00                     TB:BF
## 837  0.000000e+00                    TB:FIP
## 838  0.000000e+00                   TB:WHIP
## 839  0.000000e+00                     TB:H9
## 840  0.000000e+00                    TB:HR9
## 841  0.000000e+00                    TB:BB9
## 842  0.000000e+00                    TB:SO9
## 843  0.000000e+00                   TB:SO.W
## 844  0.000000e+00                      TB:G
## 845  0.000000e+00                    TB:Inn
## 846  0.000000e+00                     TB:Ch
## 847  0.000000e+00                     TB:PO
## 848  0.000000e+00                      TB:A
## 849  0.000000e+00                      TB:E
## 850  0.000000e+00                     TB:DP
## 851  0.000000e+00                   TB:Fld.
## 852  0.000000e+00                   TB:RF.9
## 853  0.000000e+00                   TB:RF.G
## 854  0.000000e+00            TB:tot_fa_war3
## 855  0.000000e+00                TB:num_fas
## 856  0.000000e+00               GDP:HBP.bat
## 857  0.000000e+00                     GDP:SH
## 858  0.000000e+00                     GDP:SF
## 859  0.000000e+00               GDP:IBB.bat
## 860  0.000000e+00             GDP:Age.pitch
## 861  0.000000e+00        GDP:W.L..same_year
## 862  0.000000e+00                     GDP:GF
## 863  0.000000e+00                    GDP:SHO
## 864  0.000000e+00                     GDP:SV
## 865  0.000000e+00                     GDP:IP
## 866  0.000000e+00               GDP:H.pitch
## 867  0.000000e+00              GDP:HR.pitch
## 868  0.000000e+00              GDP:BB.pitch
## 869  0.000000e+00             GDP:IBB.pitch
## 870  0.000000e+00              GDP:SO.pitch
## 871  0.000000e+00             GDP:HBP.pitch
## 872  0.000000e+00                     GDP:BK
## 873  0.000000e+00                     GDP:WP
## 874  0.000000e+00                     GDP:BF
```

```
## 875  0.000000e+00                  GDP:FIP
## 876  0.000000e+00                 GDP:WHIP
## 877  0.000000e+00                   GDP:H9
## 878  0.000000e+00                  GDP:HR9
## 879  0.000000e+00                  GDP:BB9
## 880  0.000000e+00                  GDP:SO9
## 881  0.000000e+00                 GDP:SO.W
## 882  0.000000e+00                    GDP:G
## 883  0.000000e+00                  GDP:Inn
## 884  0.000000e+00                   GDP:Ch
## 885  0.000000e+00                   GDP:PO
## 886  0.000000e+00                    GDP:A
## 887  0.000000e+00                    GDP:E
## 888  0.000000e+00                   GDP:DP
## 889  0.000000e+00                 GDP:Fld.
## 890  0.000000e+00                 GDP:RF.9
## 891  0.000000e+00                 GDP:RF.G
## 892  0.000000e+00           GDP:tot_fa_war3
## 894  0.000000e+00                HBP.bat:SH
## 895  0.000000e+00                HBP.bat:SF
## 896  0.000000e+00          HBP.bat:IBB.bat
## 897  0.000000e+00        HBP.bat:Age.pitch
## 898  0.000000e+00    HBP.bat:W.L..same_year
## 899  0.000000e+00                HBP.bat:GF
## 900  0.000000e+00               HBP.bat:SHO
## 901  0.000000e+00                HBP.bat:SV
## 902  0.000000e+00                HBP.bat:IP
## 903  0.000000e+00          HBP.bat:H.pitch
## 904  0.000000e+00         HBP.bat:HR.pitch
## 905  0.000000e+00         HBP.bat:BB.pitch
## 906  0.000000e+00        HBP.bat:IBB.pitch
## 907  0.000000e+00         HBP.bat:SO.pitch
## 908  0.000000e+00        HBP.bat:HBP.pitch
## 909  0.000000e+00                HBP.bat:BK
## 910  0.000000e+00                HBP.bat:WP
## 911  0.000000e+00                HBP.bat:BF
## 912  0.000000e+00               HBP.bat:FIP
## 913  0.000000e+00              HBP.bat:WHIP
## 914  0.000000e+00                HBP.bat:H9
## 916  0.000000e+00               HBP.bat:BB9
## 917  0.000000e+00               HBP.bat:SO9
## 918  0.000000e+00              HBP.bat:SO.W
## 919  0.000000e+00                 HBP.bat:G
## 920  0.000000e+00               HBP.bat:Inn
## 921  0.000000e+00                HBP.bat:Ch
## 922  0.000000e+00                HBP.bat:PO
## 923  0.000000e+00                 HBP.bat:A
## 924  0.000000e+00                 HBP.bat:E
## 925  0.000000e+00                HBP.bat:DP
## 926  0.000000e+00              HBP.bat:Fld.
## 927  0.000000e+00              HBP.bat:RF.9
## 928  0.000000e+00              HBP.bat:RF.G
## 929  0.000000e+00        HBP.bat:tot_fa_war3
## 930  0.000000e+00            HBP.bat:num_fas
```

```
## 931  0.000000e+00                  SH:SF
## 932  0.000000e+00               SH:IBB.bat
## 933  0.000000e+00             SH:Age.pitch
## 934  0.000000e+00        SH:W.L..same_year
## 935  0.000000e+00                  SH:GF
## 937  0.000000e+00                  SH:SV
## 938  0.000000e+00                  SH:IP
## 939  0.000000e+00               SH:H.pitch
## 940  0.000000e+00              SH:HR.pitch
## 941  0.000000e+00              SH:BB.pitch
## 942  0.000000e+00             SH:IBB.pitch
## 943  0.000000e+00              SH:SO.pitch
## 944  0.000000e+00             SH:HBP.pitch
## 945  0.000000e+00                  SH:BK
## 946  0.000000e+00                  SH:WP
## 947  0.000000e+00                  SH:BF
## 948  0.000000e+00                 SH:FIP
## 949  0.000000e+00                SH:WHIP
## 950  0.000000e+00                  SH:H9
## 951  0.000000e+00                 SH:HR9
## 952  0.000000e+00                 SH:BB9
## 953  0.000000e+00                 SH:SO9
## 954  0.000000e+00                SH:SO.W
## 955  0.000000e+00                   SH:G
## 956  0.000000e+00                 SH:Inn
## 957  0.000000e+00                  SH:Ch
## 958  0.000000e+00                  SH:PO
## 959  0.000000e+00                   SH:A
## 960  0.000000e+00                   SH:E
## 961  0.000000e+00                  SH:DP
## 962  0.000000e+00                SH:Fld.
## 963  0.000000e+00                SH:RF.9
## 964  0.000000e+00                SH:RF.G
## 965  0.000000e+00           SH:tot_fa_war3
## 966  0.000000e+00               SH:num_fas
## 967  0.000000e+00                  SF:IBB.bat
## 968  0.000000e+00             SF:Age.pitch
## 969  0.000000e+00        SF:W.L..same_year
## 970  0.000000e+00                  SF:GF
## 971  0.000000e+00                 SF:SHO
## 972  0.000000e+00                  SF:SV
## 973  0.000000e+00                  SF:IP
## 974  0.000000e+00               SF:H.pitch
## 975  0.000000e+00              SF:HR.pitch
## 976  0.000000e+00              SF:BB.pitch
## 977  0.000000e+00             SF:IBB.pitch
## 978  0.000000e+00              SF:SO.pitch
## 979  0.000000e+00             SF:HBP.pitch
## 980  0.000000e+00                  SF:BK
## 981  0.000000e+00                  SF:WP
## 982  0.000000e+00                  SF:BF
## 983  0.000000e+00                 SF:FIP
## 984  0.000000e+00                SF:WHIP
## 985  0.000000e+00                  SF:H9
```

```
## 987  0.000000e+00                   SF:BB9
## 988  0.000000e+00                   SF:SO9
## 989  0.000000e+00                  SF:SO.W
## 990  0.000000e+00                     SF:G
## 991  0.000000e+00                   SF:Inn
## 992  0.000000e+00                    SF:Ch
## 993  0.000000e+00                    SF:PO
## 994  0.000000e+00                     SF:A
## 995  0.000000e+00                     SF:E
## 996  0.000000e+00                    SF:DP
## 997  0.000000e+00                  SF:Fld.
## 998  0.000000e+00                  SF:RF.9
## 999  0.000000e+00                  SF:RF.G
## 1000 0.000000e+00             SF:tot_fa_war3
## 1001 0.000000e+00                 SF:num_fas
## 1002 0.000000e+00          IBB.bat:Age.pitch
## 1003 0.000000e+00     IBB.bat:W.L..same_year
## 1004 0.000000e+00                 IBB.bat:GF
## 1005 0.000000e+00                IBB.bat:SHO
## 1006 0.000000e+00                 IBB.bat:SV
## 1007 0.000000e+00                 IBB.bat:IP
## 1008 0.000000e+00            IBB.bat:H.pitch
## 1009 0.000000e+00           IBB.bat:HR.pitch
## 1010 0.000000e+00           IBB.bat:BB.pitch
## 1011 0.000000e+00          IBB.bat:IBB.pitch
## 1012 0.000000e+00           IBB.bat:SO.pitch
## 1013 0.000000e+00          IBB.bat:HBP.pitch
## 1014 0.000000e+00                 IBB.bat:BK
## 1015 0.000000e+00                 IBB.bat:WP
## 1016 0.000000e+00                 IBB.bat:BF
## 1017 0.000000e+00                IBB.bat:FIP
## 1018 0.000000e+00               IBB.bat:WHIP
## 1019 0.000000e+00                 IBB.bat:H9
## 1020 0.000000e+00                IBB.bat:HR9
## 1021 0.000000e+00                IBB.bat:BB9
## 1022 0.000000e+00                IBB.bat:SO9
## 1024 0.000000e+00                  IBB.bat:G
## 1025 0.000000e+00                IBB.bat:Inn
## 1026 0.000000e+00                 IBB.bat:Ch
## 1027 0.000000e+00                 IBB.bat:PO
## 1028 0.000000e+00                  IBB.bat:A
## 1029 0.000000e+00                  IBB.bat:E
## 1031 0.000000e+00               IBB.bat:Fld.
## 1032 0.000000e+00               IBB.bat:RF.9
## 1033 0.000000e+00               IBB.bat:RF.G
## 1034 0.000000e+00          IBB.bat:tot_fa_war3
## 1035 0.000000e+00              IBB.bat:num_fas
## 1037 0.000000e+00                 Age.pitch:GF
## 1038 0.000000e+00                Age.pitch:SHO
## 1039 0.000000e+00                 Age.pitch:SV
## 1040 0.000000e+00                 Age.pitch:IP
## 1041 0.000000e+00            Age.pitch:H.pitch
## 1042 0.000000e+00           Age.pitch:HR.pitch
## 1043 0.000000e+00           Age.pitch:BB.pitch
```

```
## 1044 0.000000e+00        Age.pitch:IBB.pitch
## 1045 0.000000e+00         Age.pitch:SO.pitch
## 1046 0.000000e+00        Age.pitch:HBP.pitch
## 1047 0.000000e+00               Age.pitch:BK
## 1048 0.000000e+00               Age.pitch:WP
## 1049 0.000000e+00               Age.pitch:BF
## 1050 0.000000e+00             Age.pitch:FIP
## 1051 0.000000e+00            Age.pitch:WHIP
## 1052 0.000000e+00              Age.pitch:H9
## 1053 0.000000e+00             Age.pitch:HR9
## 1054 0.000000e+00             Age.pitch:BB9
## 1055 0.000000e+00             Age.pitch:SO9
## 1056 0.000000e+00            Age.pitch:SO.W
## 1059 0.000000e+00              Age.pitch:Ch
## 1060 0.000000e+00              Age.pitch:PO
## 1061 0.000000e+00               Age.pitch:A
## 1062 0.000000e+00               Age.pitch:E
## 1063 0.000000e+00              Age.pitch:DP
## 1064 0.000000e+00            Age.pitch:Fld.
## 1065 0.000000e+00            Age.pitch:RF.9
## 1066 0.000000e+00            Age.pitch:RF.G
## 1067 0.000000e+00      Age.pitch:tot_fa_war3
## 1068 0.000000e+00          Age.pitch:num_fas
## 1069 0.000000e+00          W.L..same_year:GF
## 1070 0.000000e+00         W.L..same_year:SHO
## 1071 0.000000e+00          W.L..same_year:SV
## 1072 0.000000e+00          W.L..same_year:IP
## 1073 0.000000e+00     W.L..same_year:H.pitch
## 1074 0.000000e+00    W.L..same_year:HR.pitch
## 1075 0.000000e+00    W.L..same_year:BB.pitch
## 1076 0.000000e+00   W.L..same_year:IBB.pitch
## 1077 0.000000e+00    W.L..same_year:SO.pitch
## 1079 0.000000e+00          W.L..same_year:BK
## 1080 0.000000e+00          W.L..same_year:WP
## 1081 0.000000e+00          W.L..same_year:BF
## 1082 0.000000e+00         W.L..same_year:FIP
## 1083 0.000000e+00        W.L..same_year:WHIP
## 1084 0.000000e+00          W.L..same_year:H9
## 1085 0.000000e+00         W.L..same_year:HR9
## 1086 0.000000e+00         W.L..same_year:BB9
## 1087 0.000000e+00         W.L..same_year:SO9
## 1088 0.000000e+00        W.L..same_year:SO.W
## 1089 0.000000e+00           W.L..same_year:G
## 1090 0.000000e+00         W.L..same_year:Inn
## 1091 0.000000e+00          W.L..same_year:Ch
## 1092 0.000000e+00          W.L..same_year:PO
## 1093 0.000000e+00           W.L..same_year:A
## 1095 0.000000e+00          W.L..same_year:DP
## 1096 0.000000e+00        W.L..same_year:Fld.
## 1097 0.000000e+00        W.L..same_year:RF.9
## 1098 0.000000e+00        W.L..same_year:RF.G
## 1099 0.000000e+00 W.L..same_year:tot_fa_war3
## 1100 0.000000e+00     W.L..same_year:num_fas
## 1101 0.000000e+00                    GF:SHO
```

```
## 1102 0.000000e+00                  GF:SV
## 1103 0.000000e+00                  GF:IP
## 1104 0.000000e+00               GF:H.pitch
## 1105 0.000000e+00              GF:HR.pitch
## 1106 0.000000e+00              GF:BB.pitch
## 1107 0.000000e+00             GF:IBB.pitch
## 1108 0.000000e+00              GF:SO.pitch
## 1109 0.000000e+00             GF:HBP.pitch
## 1110 0.000000e+00                    GF:BK
## 1111 0.000000e+00                    GF:WP
## 1112 0.000000e+00                    GF:BF
## 1113 0.000000e+00                   GF:FIP
## 1114 0.000000e+00                  GF:WHIP
## 1115 0.000000e+00                    GF:H9
## 1116 0.000000e+00                   GF:HR9
## 1117 0.000000e+00                   GF:BB9
## 1118 0.000000e+00                   GF:SO9
## 1119 0.000000e+00                  GF:SO.W
## 1120 0.000000e+00                     GF:G
## 1121 0.000000e+00                   GF:Inn
## 1122 0.000000e+00                    GF:Ch
## 1123 0.000000e+00                    GF:PO
## 1124 0.000000e+00                     GF:A
## 1125 0.000000e+00                     GF:E
## 1126 0.000000e+00                    GF:DP
## 1127 0.000000e+00                  GF:Fld.
## 1128 0.000000e+00                  GF:RF.9
## 1129 0.000000e+00                  GF:RF.G
## 1130 0.000000e+00           GF:tot_fa_war3
## 1131 0.000000e+00               GF:num_fas
## 1132 0.000000e+00                   SHO:SV
## 1133 0.000000e+00                   SHO:IP
## 1134 0.000000e+00                SHO:H.pitch
## 1135 0.000000e+00               SHO:HR.pitch
## 1136 0.000000e+00               SHO:BB.pitch
## 1137 0.000000e+00              SHO:IBB.pitch
## 1138 0.000000e+00               SHO:SO.pitch
## 1139 0.000000e+00              SHO:HBP.pitch
## 1140 0.000000e+00                     SHO:BK
## 1141 0.000000e+00                     SHO:WP
## 1142 0.000000e+00                     SHO:BF
## 1143 0.000000e+00                    SHO:FIP
## 1144 0.000000e+00                   SHO:WHIP
## 1145 0.000000e+00                     SHO:H9
## 1146 0.000000e+00                    SHO:HR9
## 1147 0.000000e+00                    SHO:BB9
## 1148 0.000000e+00                    SHO:SO9
## 1149 0.000000e+00                   SHO:SO.W
## 1150 0.000000e+00                      SHO:G
## 1151 0.000000e+00                    SHO:Inn
## 1152 0.000000e+00                     SHO:Ch
## 1153 0.000000e+00                     SHO:PO
## 1154 0.000000e+00                      SHO:A
## 1156 0.000000e+00                     SHO:DP
```

```
## 1157 0.000000e+00                SHO:Fld.
## 1158 0.000000e+00                SHO:RF.9
## 1159 0.000000e+00                SHO:RF.G
## 1160 0.000000e+00           SHO:tot_fa_war3
## 1161 0.000000e+00               SHO:num_fas
## 1162 0.000000e+00                     SV:IP
## 1163 0.000000e+00                SV:H.pitch
## 1164 0.000000e+00               SV:HR.pitch
## 1165 0.000000e+00               SV:BB.pitch
## 1166 0.000000e+00              SV:IBB.pitch
## 1167 0.000000e+00               SV:SO.pitch
## 1168 0.000000e+00              SV:HBP.pitch
## 1169 0.000000e+00                     SV:BK
## 1170 0.000000e+00                     SV:WP
## 1171 0.000000e+00                     SV:BF
## 1172 0.000000e+00                    SV:FIP
## 1173 0.000000e+00                   SV:WHIP
## 1174 0.000000e+00                     SV:H9
## 1175 0.000000e+00                    SV:HR9
## 1177 0.000000e+00                    SV:SO9
## 1178 0.000000e+00                   SV:SO.W
## 1179 0.000000e+00                      SV:G
## 1180 0.000000e+00                    SV:Inn
## 1181 0.000000e+00                     SV:Ch
## 1182 0.000000e+00                     SV:PO
## 1183 0.000000e+00                      SV:A
## 1184 0.000000e+00                      SV:E
## 1185 0.000000e+00                     SV:DP
## 1186 0.000000e+00                   SV:Fld.
## 1187 0.000000e+00                   SV:RF.9
## 1188 0.000000e+00                   SV:RF.G
## 1189 0.000000e+00            SV:tot_fa_war3
## 1190 0.000000e+00                SV:num_fas
## 1191 0.000000e+00                IP:H.pitch
## 1192 0.000000e+00               IP:HR.pitch
## 1193 0.000000e+00               IP:BB.pitch
## 1194 0.000000e+00              IP:IBB.pitch
## 1195 0.000000e+00               IP:SO.pitch
## 1196 0.000000e+00              IP:HBP.pitch
## 1197 0.000000e+00                     IP:BK
## 1198 0.000000e+00                     IP:WP
## 1199 0.000000e+00                     IP:BF
## 1200 0.000000e+00                    IP:FIP
## 1201 0.000000e+00                   IP:WHIP
## 1202 0.000000e+00                     IP:H9
## 1203 0.000000e+00                    IP:HR9
## 1204 0.000000e+00                    IP:BB9
## 1205 0.000000e+00                    IP:SO9
## 1206 0.000000e+00                   IP:SO.W
## 1207 0.000000e+00                      IP:G
## 1208 0.000000e+00                    IP:Inn
## 1209 0.000000e+00                     IP:Ch
## 1210 0.000000e+00                     IP:PO
## 1211 0.000000e+00                      IP:A
```

```
## 1212 0.000000e+00                    IP:E
## 1213 0.000000e+00                   IP:DP
## 1214 0.000000e+00                  IP:Fld.
## 1215 0.000000e+00                  IP:RF.9
## 1216 0.000000e+00                  IP:RF.G
## 1217 0.000000e+00             IP:tot_fa_war3
## 1218 0.000000e+00                 IP:num_fas
## 1219 0.000000e+00           H.pitch:HR.pitch
## 1220 0.000000e+00           H.pitch:BB.pitch
## 1221 0.000000e+00          H.pitch:IBB.pitch
## 1222 0.000000e+00           H.pitch:SO.pitch
## 1223 0.000000e+00          H.pitch:HBP.pitch
## 1224 0.000000e+00                 H.pitch:BK
## 1225 0.000000e+00                 H.pitch:WP
## 1226 0.000000e+00                 H.pitch:BF
## 1227 0.000000e+00                H.pitch:FIP
## 1228 0.000000e+00               H.pitch:WHIP
## 1229 0.000000e+00                 H.pitch:H9
## 1230 0.000000e+00                H.pitch:HR9
## 1231 0.000000e+00                H.pitch:BB9
## 1233 0.000000e+00               H.pitch:SO.W
## 1234 0.000000e+00                  H.pitch:G
## 1235 0.000000e+00                H.pitch:Inn
## 1236 0.000000e+00                 H.pitch:Ch
## 1237 0.000000e+00                 H.pitch:PO
## 1238 0.000000e+00                  H.pitch:A
## 1239 0.000000e+00                  H.pitch:E
## 1240 0.000000e+00                 H.pitch:DP
## 1241 0.000000e+00               H.pitch:Fld.
## 1242 0.000000e+00               H.pitch:RF.9
## 1243 0.000000e+00               H.pitch:RF.G
## 1244 0.000000e+00        H.pitch:tot_fa_war3
## 1245 0.000000e+00            H.pitch:num_fas
## 1246 0.000000e+00          HR.pitch:BB.pitch
## 1247 0.000000e+00         HR.pitch:IBB.pitch
## 1248 0.000000e+00          HR.pitch:SO.pitch
## 1249 0.000000e+00         HR.pitch:HBP.pitch
## 1250 0.000000e+00                HR.pitch:BK
## 1251 0.000000e+00                HR.pitch:WP
## 1252 0.000000e+00                HR.pitch:BF
## 1253 0.000000e+00               HR.pitch:FIP
## 1254 0.000000e+00              HR.pitch:WHIP
## 1255 0.000000e+00                HR.pitch:H9
## 1256 0.000000e+00               HR.pitch:HR9
## 1257 0.000000e+00               HR.pitch:BB9
## 1258 0.000000e+00               HR.pitch:SO9
## 1259 0.000000e+00              HR.pitch:SO.W
## 1260 0.000000e+00                 HR.pitch:G
## 1261 0.000000e+00               HR.pitch:Inn
## 1262 0.000000e+00                HR.pitch:Ch
## 1263 0.000000e+00                HR.pitch:PO
## 1264 0.000000e+00                 HR.pitch:A
## 1265 0.000000e+00                 HR.pitch:E
## 1266 0.000000e+00                HR.pitch:DP
```

```
## 1267 0.000000e+00              HR.pitch:Fld.
## 1268 0.000000e+00              HR.pitch:RF.9
## 1269 0.000000e+00              HR.pitch:RF.G
## 1270 0.000000e+00       HR.pitch:tot_fa_war3
## 1271 0.000000e+00           HR.pitch:num_fas
## 1272 0.000000e+00         BB.pitch:IBB.pitch
## 1273 0.000000e+00          BB.pitch:SO.pitch
## 1274 0.000000e+00         BB.pitch:HBP.pitch
## 1275 0.000000e+00                BB.pitch:BK
## 1276 0.000000e+00                BB.pitch:WP
## 1277 0.000000e+00                BB.pitch:BF
## 1278 0.000000e+00               BB.pitch:FIP
## 1279 0.000000e+00              BB.pitch:WHIP
## 1280 0.000000e+00                BB.pitch:H9
## 1281 0.000000e+00               BB.pitch:HR9
## 1282 0.000000e+00               BB.pitch:BB9
## 1283 0.000000e+00               BB.pitch:SO9
## 1284 0.000000e+00              BB.pitch:SO.W
## 1285 0.000000e+00                 BB.pitch:G
## 1286 0.000000e+00               BB.pitch:Inn
## 1287 0.000000e+00                BB.pitch:Ch
## 1288 0.000000e+00                BB.pitch:PO
## 1289 0.000000e+00                 BB.pitch:A
## 1290 0.000000e+00                 BB.pitch:E
## 1291 0.000000e+00                BB.pitch:DP
## 1292 0.000000e+00              BB.pitch:Fld.
## 1293 0.000000e+00              BB.pitch:RF.9
## 1294 0.000000e+00              BB.pitch:RF.G
## 1295 0.000000e+00       BB.pitch:tot_fa_war3
## 1296 0.000000e+00           BB.pitch:num_fas
## 1297 0.000000e+00         IBB.pitch:SO.pitch
## 1298 0.000000e+00        IBB.pitch:HBP.pitch
## 1300 0.000000e+00               IBB.pitch:WP
## 1301 0.000000e+00               IBB.pitch:BF
## 1302 0.000000e+00              IBB.pitch:FIP
## 1303 0.000000e+00             IBB.pitch:WHIP
## 1304 0.000000e+00               IBB.pitch:H9
## 1305 0.000000e+00              IBB.pitch:HR9
## 1306 0.000000e+00              IBB.pitch:BB9
## 1307 0.000000e+00              IBB.pitch:SO9
## 1308 0.000000e+00             IBB.pitch:SO.W
## 1309 0.000000e+00                IBB.pitch:G
## 1310 0.000000e+00              IBB.pitch:Inn
## 1311 0.000000e+00               IBB.pitch:Ch
## 1312 0.000000e+00               IBB.pitch:PO
## 1313 0.000000e+00                IBB.pitch:A
## 1314 0.000000e+00                IBB.pitch:E
## 1315 0.000000e+00               IBB.pitch:DP
## 1316 0.000000e+00             IBB.pitch:Fld.
## 1317 0.000000e+00             IBB.pitch:RF.9
## 1318 0.000000e+00             IBB.pitch:RF.G
## 1320 0.000000e+00          IBB.pitch:num_fas
## 1321 0.000000e+00         SO.pitch:HBP.pitch
## 1322 0.000000e+00                SO.pitch:BK
```

```
## 1323 0.000000e+00               SO.pitch:WP
## 1324 0.000000e+00               SO.pitch:BF
## 1325 0.000000e+00              SO.pitch:FIP
## 1326 0.000000e+00             SO.pitch:WHIP
## 1327 0.000000e+00               SO.pitch:H9
## 1328 0.000000e+00              SO.pitch:HR9
## 1329 0.000000e+00              SO.pitch:BB9
## 1330 0.000000e+00              SO.pitch:SO9
## 1331 0.000000e+00             SO.pitch:SO.W
## 1332 0.000000e+00                 SO.pitch:G
## 1333 0.000000e+00              SO.pitch:Inn
## 1334 0.000000e+00               SO.pitch:Ch
## 1335 0.000000e+00               SO.pitch:PO
## 1336 0.000000e+00                SO.pitch:A
## 1337 0.000000e+00                SO.pitch:E
## 1338 0.000000e+00               SO.pitch:DP
## 1339 0.000000e+00             SO.pitch:Fld.
## 1340 0.000000e+00             SO.pitch:RF.9
## 1341 0.000000e+00             SO.pitch:RF.G
## 1342 0.000000e+00       SO.pitch:tot_fa_war3
## 1343 0.000000e+00           SO.pitch:num_fas
## 1344 0.000000e+00               HBP.pitch:BK
## 1345 0.000000e+00               HBP.pitch:WP
## 1346 0.000000e+00               HBP.pitch:BF
## 1347 0.000000e+00              HBP.pitch:FIP
## 1348 0.000000e+00             HBP.pitch:WHIP
## 1349 0.000000e+00               HBP.pitch:H9
## 1350 0.000000e+00              HBP.pitch:HR9
## 1351 0.000000e+00              HBP.pitch:BB9
## 1352 0.000000e+00              HBP.pitch:SO9
## 1353 0.000000e+00             HBP.pitch:SO.W
## 1354 0.000000e+00                 HBP.pitch:G
## 1355 0.000000e+00              HBP.pitch:Inn
## 1356 0.000000e+00               HBP.pitch:Ch
## 1357 0.000000e+00               HBP.pitch:PO
## 1358 0.000000e+00                HBP.pitch:A
## 1359 0.000000e+00                HBP.pitch:E
## 1360 0.000000e+00               HBP.pitch:DP
## 1361 0.000000e+00             HBP.pitch:Fld.
## 1362 0.000000e+00             HBP.pitch:RF.9
## 1363 0.000000e+00             HBP.pitch:RF.G
## 1365 0.000000e+00         HBP.pitch:num_fas
## 1367 0.000000e+00                     BK:BF
## 1368 0.000000e+00                    BK:FIP
## 1369 0.000000e+00                   BK:WHIP
## 1370 0.000000e+00                     BK:H9
## 1371 0.000000e+00                    BK:HR9
## 1372 0.000000e+00                    BK:BB9
## 1373 0.000000e+00                    BK:SO9
## 1374 0.000000e+00                   BK:SO.W
## 1375 0.000000e+00                       BK:G
## 1376 0.000000e+00                    BK:Inn
## 1377 0.000000e+00                     BK:Ch
## 1378 0.000000e+00                     BK:PO
```

```
## 1379 0.000000e+00                   BK:A
## 1380 0.000000e+00                   BK:E
## 1381 0.000000e+00                  BK:DP
## 1382 0.000000e+00                 BK:Fld.
## 1383 0.000000e+00                 BK:RF.9
## 1384 0.000000e+00                 BK:RF.G
## 1385 0.000000e+00           BK:tot_fa_war3
## 1386 0.000000e+00               BK:num_fas
## 1387 0.000000e+00                    WP:BF
## 1388 0.000000e+00                   WP:FIP
## 1389 0.000000e+00                  WP:WHIP
## 1390 0.000000e+00                    WP:H9
## 1391 0.000000e+00                   WP:HR9
## 1392 0.000000e+00                   WP:BB9
## 1393 0.000000e+00                   WP:SO9
## 1394 0.000000e+00                  WP:SO.W
## 1395 0.000000e+00                     WP:G
## 1396 0.000000e+00                   WP:Inn
## 1397 0.000000e+00                    WP:Ch
## 1398 0.000000e+00                    WP:PO
## 1399 0.000000e+00                     WP:A
## 1400 0.000000e+00                     WP:E
## 1401 0.000000e+00                    WP:DP
## 1402 0.000000e+00                  WP:Fld.
## 1403 0.000000e+00                  WP:RF.9
## 1404 0.000000e+00                  WP:RF.G
## 1405 0.000000e+00           WP:tot_fa_war3
## 1406 0.000000e+00               WP:num_fas
## 1407 0.000000e+00                   BF:FIP
## 1408 0.000000e+00                  BF:WHIP
## 1409 0.000000e+00                    BF:H9
## 1410 0.000000e+00                   BF:HR9
## 1411 0.000000e+00                   BF:BB9
## 1412 0.000000e+00                   BF:SO9
## 1413 0.000000e+00                  BF:SO.W
## 1414 0.000000e+00                     BF:G
## 1415 0.000000e+00                   BF:Inn
## 1416 0.000000e+00                    BF:Ch
## 1417 0.000000e+00                    BF:PO
## 1418 0.000000e+00                     BF:A
## 1419 0.000000e+00                     BF:E
## 1420 0.000000e+00                    BF:DP
## 1421 0.000000e+00                  BF:Fld.
## 1422 0.000000e+00                  BF:RF.9
## 1423 0.000000e+00                  BF:RF.G
## 1424 0.000000e+00           BF:tot_fa_war3
## 1425 0.000000e+00               BF:num_fas
## 1426 0.000000e+00                 FIP:WHIP
## 1427 0.000000e+00                   FIP:H9
## 1428 0.000000e+00                  FIP:HR9
## 1429 0.000000e+00                  FIP:BB9
## 1430 0.000000e+00                  FIP:SO9
## 1431 0.000000e+00                 FIP:SO.W
## 1432 0.000000e+00                    FIP:G
```

```
## 1433 0.000000e+00                  FIP:Inn
## 1434 0.000000e+00                   FIP:Ch
## 1435 0.000000e+00                   FIP:PO
## 1436 0.000000e+00                    FIP:A
## 1437 0.000000e+00                    FIP:E
## 1438 0.000000e+00                   FIP:DP
## 1439 0.000000e+00                 FIP:Fld.
## 1440 0.000000e+00                 FIP:RF.9
## 1441 0.000000e+00                 FIP:RF.G
## 1442 0.000000e+00           FIP:tot_fa_war3
## 1443 0.000000e+00               FIP:num_fas
## 1444 0.000000e+00                   WHIP:H9
## 1445 0.000000e+00                 WHIP:HR9
## 1446 0.000000e+00                 WHIP:BB9
## 1448 0.000000e+00                WHIP:SO.W
## 1449 0.000000e+00                   WHIP:G
## 1450 0.000000e+00                 WHIP:Inn
## 1451 0.000000e+00                  WHIP:Ch
## 1452 0.000000e+00                  WHIP:PO
## 1453 0.000000e+00                   WHIP:A
## 1454 0.000000e+00                   WHIP:E
## 1455 0.000000e+00                  WHIP:DP
## 1456 0.000000e+00                WHIP:Fld.
## 1457 0.000000e+00                WHIP:RF.9
## 1459 0.000000e+00          WHIP:tot_fa_war3
## 1460 0.000000e+00              WHIP:num_fas
## 1461 0.000000e+00                    H9:HR9
## 1462 0.000000e+00                    H9:BB9
## 1463 0.000000e+00                    H9:SO9
## 1464 0.000000e+00                   H9:SO.W
## 1465 0.000000e+00                      H9:G
## 1466 0.000000e+00                    H9:Inn
## 1467 0.000000e+00                     H9:Ch
## 1468 0.000000e+00                     H9:PO
## 1469 0.000000e+00                      H9:A
## 1470 0.000000e+00                      H9:E
## 1471 0.000000e+00                     H9:DP
## 1472 0.000000e+00                   H9:Fld.
## 1473 0.000000e+00                   H9:RF.9
## 1474 0.000000e+00                   H9:RF.G
## 1475 0.000000e+00            H9:tot_fa_war3
## 1476 0.000000e+00                H9:num_fas
## 1477 0.000000e+00                   HR9:BB9
## 1478 0.000000e+00                   HR9:SO9
## 1479 0.000000e+00                  HR9:SO.W
## 1480 0.000000e+00                     HR9:G
## 1481 0.000000e+00                   HR9:Inn
## 1482 0.000000e+00                    HR9:Ch
## 1483 0.000000e+00                    HR9:PO
## 1484 0.000000e+00                     HR9:A
## 1485 0.000000e+00                     HR9:E
## 1486 0.000000e+00                    HR9:DP
## 1487 0.000000e+00                  HR9:Fld.
## 1488 0.000000e+00                  HR9:RF.9
```

```
## 1489 0.000000e+00                HR9:RF.G
## 1490 0.000000e+00           HR9:tot_fa_war3
## 1491 0.000000e+00               HR9:num_fas
## 1492 0.000000e+00                   BB9:SO9
## 1493 0.000000e+00                  BB9:SO.W
## 1494 0.000000e+00                     BB9:G
## 1495 0.000000e+00                   BB9:Inn
## 1496 0.000000e+00                    BB9:Ch
## 1497 0.000000e+00                    BB9:PO
## 1498 0.000000e+00                     BB9:A
## 1499 0.000000e+00                     BB9:E
## 1500 0.000000e+00                    BB9:DP
## 1501 0.000000e+00                  BB9:Fld.
## 1502 0.000000e+00                  BB9:RF.9
## 1503 0.000000e+00                  BB9:RF.G
## 1504 0.000000e+00           BB9:tot_fa_war3
## 1506 0.000000e+00                  SO9:SO.W
## 1507 0.000000e+00                     SO9:G
## 1508 0.000000e+00                   SO9:Inn
## 1509 0.000000e+00                    SO9:Ch
## 1510 0.000000e+00                    SO9:PO
## 1511 0.000000e+00                     SO9:A
## 1513 0.000000e+00                    SO9:DP
## 1514 0.000000e+00                  SO9:Fld.
## 1515 0.000000e+00                  SO9:RF.9
## 1516 0.000000e+00                  SO9:RF.G
## 1518 0.000000e+00               SO9:num_fas
## 1519 0.000000e+00                    SO.W:G
## 1520 0.000000e+00                  SO.W:Inn
## 1521 0.000000e+00                   SO.W:Ch
## 1522 0.000000e+00                   SO.W:PO
## 1523 0.000000e+00                    SO.W:A
## 1524 0.000000e+00                    SO.W:E
## 1525 0.000000e+00                   SO.W:DP
## 1526 0.000000e+00                 SO.W:Fld.
## 1527 0.000000e+00                 SO.W:RF.9
## 1528 0.000000e+00                 SO.W:RF.G
## 1530 0.000000e+00              SO.W:num_fas
## 1531 0.000000e+00                     G:Inn
## 1532 0.000000e+00                      G:Ch
## 1533 0.000000e+00                      G:PO
## 1534 0.000000e+00                       G:A
## 1536 0.000000e+00                      G:DP
## 1537 0.000000e+00                    G:Fld.
## 1538 0.000000e+00                    G:RF.9
## 1539 0.000000e+00                    G:RF.G
## 1540 0.000000e+00             G:tot_fa_war3
## 1541 0.000000e+00                 G:num_fas
## 1542 0.000000e+00                    Inn:Ch
## 1543 0.000000e+00                    Inn:PO
## 1544 0.000000e+00                     Inn:A
## 1546 0.000000e+00                    Inn:DP
## 1547 0.000000e+00                  Inn:Fld.
## 1548 0.000000e+00                  Inn:RF.9
```

```
## 1549 0.000000e+00                 Inn:RF.G
## 1550 0.000000e+00            Inn:tot_fa_war3
## 1551 0.000000e+00                Inn:num_fas
## 1552 0.000000e+00                     Ch:PO
## 1553 0.000000e+00                      Ch:A
## 1554 0.000000e+00                      Ch:E
## 1555 0.000000e+00                     Ch:DP
## 1556 0.000000e+00                   Ch:Fld.
## 1557 0.000000e+00                   Ch:RF.9
## 1558 0.000000e+00                   Ch:RF.G
## 1559 0.000000e+00              Ch:tot_fa_war3
## 1560 0.000000e+00                  Ch:num_fas
## 1561 0.000000e+00                      PO:A
## 1562 0.000000e+00                      PO:E
## 1563 0.000000e+00                     PO:DP
## 1564 0.000000e+00                   PO:Fld.
## 1565 0.000000e+00                   PO:RF.9
## 1566 0.000000e+00                   PO:RF.G
## 1567 0.000000e+00              PO:tot_fa_war3
## 1568 0.000000e+00                  PO:num_fas
## 1569 0.000000e+00                       A:E
## 1570 0.000000e+00                      A:DP
## 1571 0.000000e+00                    A:Fld.
## 1572 0.000000e+00                    A:RF.9
## 1573 0.000000e+00                    A:RF.G
## 1574 0.000000e+00               A:tot_fa_war3
## 1575 0.000000e+00                   A:num_fas
## 1576 0.000000e+00                       E:DP
## 1577 0.000000e+00                     E:Fld.
## 1578 0.000000e+00                     E:RF.9
## 1579 0.000000e+00                     E:RF.G
## 1580 0.000000e+00               E:tot_fa_war3
## 1581 0.000000e+00                   E:num_fas
## 1582 0.000000e+00                    DP:Fld.
## 1583 0.000000e+00                    DP:RF.9
## 1584 0.000000e+00                    DP:RF.G
## 1585 0.000000e+00              DP:tot_fa_war3
## 1586 0.000000e+00                  DP:num_fas
## 1587 0.000000e+00                   Fld.:RF.9
## 1588 0.000000e+00                   Fld.:RF.G
## 1589 0.000000e+00             Fld.:tot_fa_war3
## 1590 0.000000e+00                 Fld.:num_fas
## 1591 0.000000e+00                    RF.9:RF.G
## 1592 0.000000e+00             RF.9:tot_fa_war3
## 1593 0.000000e+00                 RF.9:num_fas
## 1594 0.000000e+00             RF.G:tot_fa_war3
## 1595 0.000000e+00                 RF.G:num_fas
## 1596 0.000000e+00          tot_fa_war3:num_fas
```

```
yhats.fullinteraction.train = predict(lassos.fullinteraction, X.fullinteraction)
lassosfullinteraction.trainRMSE = RMSE(train.df$W.L..next_year, yhats.fullinteraction.train) # train RM
lassosfullinteraction.trainR2 = R2(train.df$W.L..next_year, yhats.fullinteraction.train) # train R2

yhats.fullinteraction.test = predict(lassos.fullinteraction, X.fullinteraction.test)
```

```
#plot(RMSE.lassos.fullinteraction.test~log(lassos.fullinteraction$lambda, 10), type='l')
lassosfullinteraction.testRMSE = RMSE(test.df$W.L..next_year, yhats.fullinteraction.test) # train RMSE
lassosfullinteraction.testR2 = R2(test.df$W.L..next_year, yhats.fullinteraction.test) # train R2
```

```
set.seed(139)
# Stepwise
lm.step = step(lm.full, scope=c(lower=formula(W.L..next_year~1),
                                upper=lm.fullinteraction), trace=0, direction="both")
formula(lm.step)
```

```
## W.L..next_year ~ Age.bat + PA + AB + H.bat + X3B + OBP + SLG +
##     OPSplus + GDP + HBP.bat + SF + Age.pitch + SV + IP + BK +
##     BF + FIP + WHIP + BB9 + Inn + Ch + PO + A + tot_fa_war3 +
##     num_fas
```

```
imp <- as.data.frame(varImp(lm.step))
imp <- data.frame(overall = imp$Overall,
           names = rownames(imp))
imp[order(imp$overall,decreasing = T),]
```

```
##     overall       names
## 24 4.811593 tot_fa_war3
## 3  4.293909          AB
## 2  3.670723          PA
## 25 3.345379     num_fas
## 5  3.308352         X3B
## 4  3.246229       H.bat
## 18 2.859374        WHIP
## 22 2.759578          PO
## 23 2.718017           A
## 21 2.704481          Ch
## 1  2.649060     Age.bat
## 11 2.553392          SF
## 7  2.487609         SLG
## 13 2.168715          SV
## 9  2.053609         GDP
## 20 1.846731         Inn
## 16 1.826916          BF
## 6  1.820625         OBP
## 15 1.719865          BK
## 8  1.713718     OPSplus
## 14 1.683418          IP
## 17 1.673831         FIP
## 19 1.633046         BB9
## 10 1.552065     HBP.bat
## 12 1.498963   Age.pitch
```

```
lmstep.trainRMSE = RMSE(train.df$W.L..next_year, predict(lm.step, newdata=train.df))
lmstep.testRMSE = RMSE(test.df$W.L..next_year, predict(lm.step, newdata=test.df))
lmstep.trainR2 = R2(train.df$W.L..next_year, predict(lm.step, newdata=train.df))
lmstep.testR2 = R2(test.df$W.L..next_year, predict(lm.step, newdata=test.df))
```

```r
set.seed(139)
# model comparison
RMSE.df = data.frame(trainRMSE = c(baseline.trainRMSE,
                                   lmfull.trainRMSE,
                                   lmfullinteraction.trainRMSE,
                                   ridgesfull.trainRMSE,
                                   ridgesfullinteraction.trainRMSE,
                                   lassosfull.trainRMSE,
                                   lassosfullinteraction.trainRMSE,
                                   lmstep.trainRMSE),
                     testRMSE = c(baseline.testRMSE,
                                   lmfull.testRMSE,
                                   lmfullinteraction.testRMSE,
                                   ridgesfull.testRMSE,
                                   ridgesfullinteraction.testRMSE,
                                   lassosfull.testRMSE,
                                   lassosfullinteraction.testRMSE,
                                   lmstep.testRMSE),
                     trainR2 = c(baseline.trainR2,
                                   lmfull.trainR2,
                                   lmfullinteraction.trainR2,
                                   ridgesfull.trainR2,
                                   ridgesfullinteraction.trainR2,
                                   lassosfull.trainR2,
                                   lassosfullinteraction.trainR2,
                                   lmstep.trainR2),
                     testR2 = c(baseline.testR2,
                                   lmfull.testR2,
                                   lmfullinteraction.testR2,
                                   ridgesfull.testR2,
                                   ridgesfullinteraction.testR2,
                                   lassosfull.testR2,
                                   lassosfullinteraction.testR2,
                                   lmstep.testR2))
rownames(RMSE.df) <- c("baseline", "full", "full interaction",
                       "ridge full", "ridge full interaction",
                       "lasso full", "lasso full interaction",
                       "step")
RMSE.df
```

```
##                           trainRMSE   testRMSE   trainR2       testR2
## baseline               6.273863e+00   7.058916 0.2932730    0.2071767
## full                   5.669061e+00   7.188524 0.4229627    0.1777956
## full interaction       6.104278e-09 157.610140 1.0000000 -394.2470839
## ridge full             5.796197e+00   6.929355 0.3967910    0.2360129
## ridge full interaction 5.741617e+00   6.961877 0.4080977    0.2288248
## lasso full             5.799022e+00   6.948096 0.3962028    0.2318749
## lasso full interaction 5.657099e+00   6.984586 0.4253954    0.2237857
## step                   5.728989e+00   7.082100 0.4106984    0.2019603
```

Decision Tree/Random Forest

```
set.seed(139)
library(rpart)

RMSE = function(y,yhat){
  return(sqrt(mean((y-yhat)^2)))
}

test.df = subset(test.df, test.df$Tm != 'CLE')
tree1 = rpart(formula(lm.full),data=train.df, control = list(minsplit=1,cp=0,maxdepth=20))
yhat.tree1.train = predict(tree1)
yhat.tree1.test = predict(tree1, newdata = test.df)
RMSE.tree1.train = RMSE(train.df$W.L..next_year,yhat.tree1.train)
RMSE.tree1.test = RMSE(test.df$W.L..next_year,yhat.tree1.test)
data.frame(train=RMSE.tree1.train,test=RMSE.tree1.test)
```

```
##    train    test
## 1 3.9511 8.43241
```

```
set.seed(139)
best.cp = tree1$cptable[,"CP"][which.min(tree1$cptable[,"xerror"])]
tree2 = prune(tree1,best.cp)
yhat.tree2.train = predict(tree2)
yhat.tree2.test = predict(tree2,newdata=test.df)
RMSE.tree2.train = RMSE(train.df$W.L..next_year,yhat.tree2.train)
RMSE.tree2.test = RMSE(test.df$W.L..next_year,yhat.tree2.test)
data.frame(train=RMSE.tree2.train,test=RMSE.tree2.test)
```

```
##      train     test
## 1 6.461346 7.490019
```

```
set.seed(139)
library(randomForest)

maxnodes = c(100,200,500)
ntree= 200
rmses.bag = rep(NA,length(maxnodes))
bestRMSE = sd(train.df$W.L..next_year)

for(i in 1:length(maxnodes)){
  bagtemp = randomForest(formula(lm.full),data=train.df,
                         mtry=56, maxnodes=maxnodes[i], ntree=ntree)
  rmses.bag[i]=RMSE(train.df$W.L..next_year, bagtemp$predicted)
  if(rmses.bag[i]<bestRMSE){
    best_maxnodes = maxnodes[i]
    bestRMSE=rmses.bag[i]
    bag=bagtemp
  }
}
data.frame(maxnodes=maxnodes, RMSE=rmses.bag)
```

```
##   maxnodes     RMSE
## 1      100 6.397272
## 2      200 6.460016
## 3      500 6.439697
```

```
yhat.bag.train = predict(bag)
yhat.bag.test = predict(bag, newdata = test.df)
RMSE.bag.train = RMSE(train.df$W.L..next_year,yhat.bag.train)
RMSE.bag.test = RMSE(test.df$W.L..next_year,yhat.bag.test)
data.frame(train=RMSE.bag.train,test=RMSE.bag.test)
```

```
##      train     test
## 1 6.397272 7.109748
```

```
library(randomForest)
set.seed(139)
maxnodes = c(100,200,500)
mtry = c(15, 25, 35, 45, 55)
ntree=200
pars = expand.grid(maxnodes=maxnodes,mtry=mtry)
RMSEs = rep(NA,nrow(pars))
bestRMSE = sd(train.df$W.L..next_year)

for(i in 1:nrow(pars)){
  rftemp = randomForest(formula(lm.full),data=train.df,
                        mtry=pars$mtry[i], maxnodes=pars$maxnodes[i], ntree=ntree)
  RMSEs[i]=RMSE(train.df$W.L..next_year, rftemp$predicted)
  if(RMSEs[i]<bestRMSE){
    best_maxnodes = maxnodes[i]
    bestRMSE=RMSEs[i]
    rf1=rftemp
  }
}
data.frame(maxnodes=pars$maxnodes,mtry=pars$mtry,RMSE=RMSEs)
```

```
##    maxnodes mtry     RMSE
## 1       100   15 6.434901
## 2       200   15 6.476828
## 3       500   15 6.464521
## 4       100   25 6.460300
## 5       200   25 6.447135
## 6       500   25 6.471577
## 7       100   35 6.417410
## 8       200   35 6.416950
## 9       500   35 6.431414
## 10      100   45 6.505922
## 11      200   45 6.477685
## 12      500   45 6.377898
## 13      100   55 6.488894
## 14      200   55 6.483632
## 15      500   55 6.434556
```

```
pars[which(RMSEs==bestRMSE),]
```

```
##    maxnodes mtry
## 12      500   45
```

```
yhat.rf1.train = predict(rf1)
yhat.rf1.test = predict(rf1, newdata = test.df)
RMSE.rf1.train = RMSE(train.df$W.L..next_year,yhat.rf1.train)
RMSE.rf1.test = RMSE(test.df$W.L..next_year,yhat.rf1.test)
data.frame(train=RMSE.rf1.train,test=RMSE.rf1.test)
```

```
##      train     test
## 1 6.377898 7.137898
```

```
importance(rf1)
```

```
##                 IncNodePurity
## Age.bat             379.6500
## PA                  134.2052
## AB                  202.4752
## H.bat               153.2252
## X2B                 235.4155
## X3B                 440.7061
## HR.bat              662.0776
## SB                  329.2822
## CS                  421.0483
## BB.bat              829.3347
## SO.bat              406.1870
## BA                  295.5659
## OBP                 546.6960
## SLG                 430.7280
## OPS                 484.9618
## OPSplus             413.0187
## TB                  152.3767
## GDP                 432.1897
## HBP.bat             460.4134
## SH                  337.8594
## SF                  268.6063
## IBB.bat             498.5717
## Age.pitch           743.6306
## W.L..same_year     3150.8236
## GF                  300.0394
## SHO                 290.4883
## SV                 1258.3371
## IP                  293.3168
## H.pitch             272.8069
## HR.pitch            296.6186
## BB.pitch            348.5045
## IBB.pitch           271.5517
## SO.pitch            536.0281
## HBP.pitch           291.8748
## BK                  454.3285
```

```
## WP                  381.2293
## BF                  218.8919
## FIP                 740.6101
## WHIP               2256.6089
## H9                 1279.5906
## HR9                 397.9306
## BB9                 609.8318
## SO9                 325.4082
## SO.W                454.5702
## G                   483.0792
## Inn                 253.6438
## Ch                  248.2340
## PO                  342.0238
## A                   328.3512
## E                   523.4479
## DP                  406.5807
## Fld.                457.3072
## RF.9                421.2885
## RF.G                462.9082
## tot_fa_war3        1220.7219
## num_fas             481.4762
```

```
library(randomForest)
set.seed(139)
maxnodes = c(100,200,500)
mtry = c(1,2,3)
ntree=200
pars = expand.grid(maxnodes=maxnodes,mtry=mtry)
RMSEs = rep(NA,nrow(pars))
bestRMSE = sd(train.df$W.L..next_year)

for(i in 1:nrow(pars)){
  rftemp = randomForest(W.L..next_year ~ W.L..same_year + WHIP + H9 + SV + tot_fa_war3, data=train.df,
                        mtry=pars$mtry[i], maxnodes=pars$maxnodes[i], ntree=ntree)
  RMSEs[i]=RMSE(train.df$W.L..next_year, rftemp$predicted)
  if(RMSEs[i]<bestRMSE){
    best_maxnodes = maxnodes[i]
    bestRMSE=RMSEs[i]
    rf2=rftemp
  }
}
data.frame(maxnodes=pars$maxnodes,mtry=pars$mtry,RMSE=RMSEs)
```

```
##   maxnodes mtry     RMSE
## 1      100    1 6.498728
## 2      200    1 6.512211
## 3      500    1 6.500416
## 4      100    2 6.521179
## 5      200    2 6.419483
## 6      500    2 6.489911
## 7      100    3 6.491971
## 8      200    3 6.491635
## 9      500    3 6.494167
```

```
pars[which(RMSEs==bestRMSE),]
```

```
##   maxnodes mtry
## 5      200    2
```

```
yhat.rf2.train = predict(rf2)
yhat.rf2.test = predict(rf2, newdata = test.df)
RMSE.rf2.train = RMSE(train.df$W.L..next_year,yhat.rf2.train)
RMSE.rf2.test = RMSE(test.df$W.L..next_year,yhat.rf2.test)
data.frame(train=RMSE.rf2.train,test=RMSE.rf2.test)
```

```
##      train     test
## 1 6.419483 7.680534
```

```
importance(rf2)
```

```
##                IncNodePurity
## W.L..same_year      6043.333
## WHIP                6223.321
## H9                  5323.218
## SV                  5546.940
## tot_fa_war3         4786.592
```

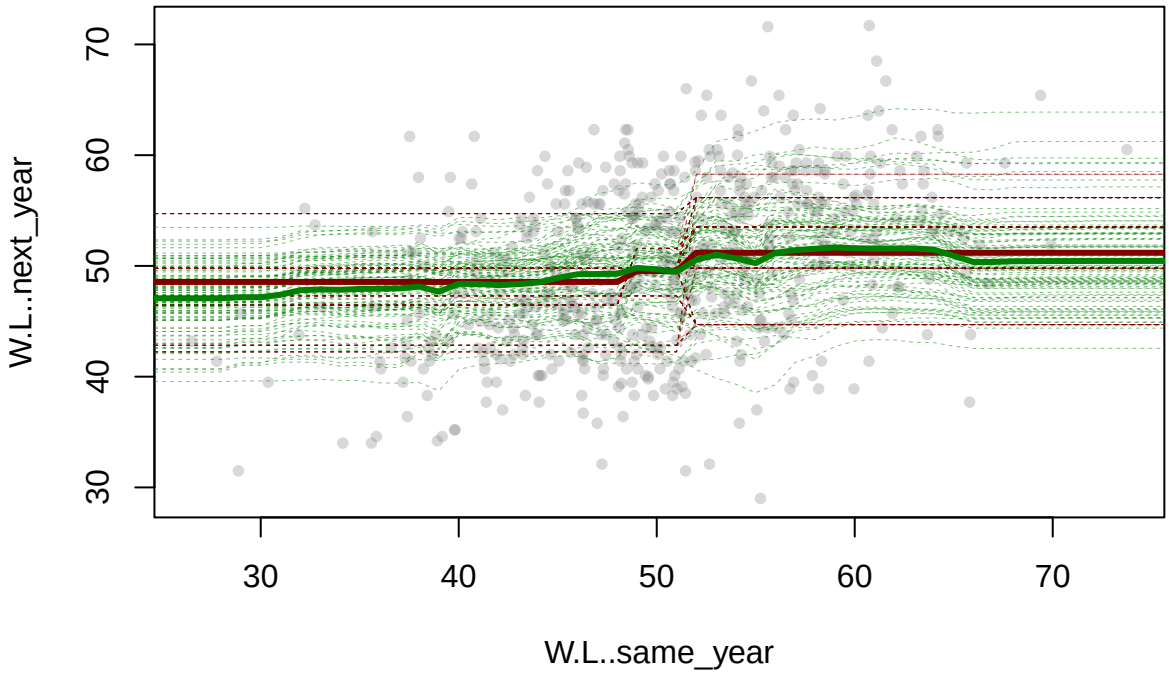
```
set.seed(139)
tree3 = rpart(W.L..next_year ~ W.L..same_year + WHIP + H9 + SV + tot_fa_war3,
              data=train.df, control = list(minsplit=1, cp=0, maxdepth=20))
yhat.tree3.train = predict(tree3)
yhat.tree3.test = predict(tree3, newdata = test.df)
RMSE.tree3.train = RMSE(train.df$W.L..next_year,yhat.tree3.train)
RMSE.tree3.test = RMSE(test.df$W.L..next_year,yhat.tree3.test)
data.frame(train=RMSE.tree3.train,test=RMSE.tree3.test)
```

```
##      train     test
## 1 4.842705 8.420162
```

```
set.seed(139)
best.cp = tree3$cptable[,"CP"][which.min(tree3$cptable[,"xerror"])]
tree4 = prune(tree3,best.cp)
yhat.tree4.train = predict(tree4)
yhat.tree4.test = predict(tree4,newdata=test.df)
RMSE.tree4.train = RMSE(train.df$W.L..next_year,yhat.tree4.train)
RMSE.tree4.test = RMSE(test.df$W.L..next_year,yhat.tree4.test)
data.frame(train=RMSE.tree4.train,test=RMSE.tree4.test)
```

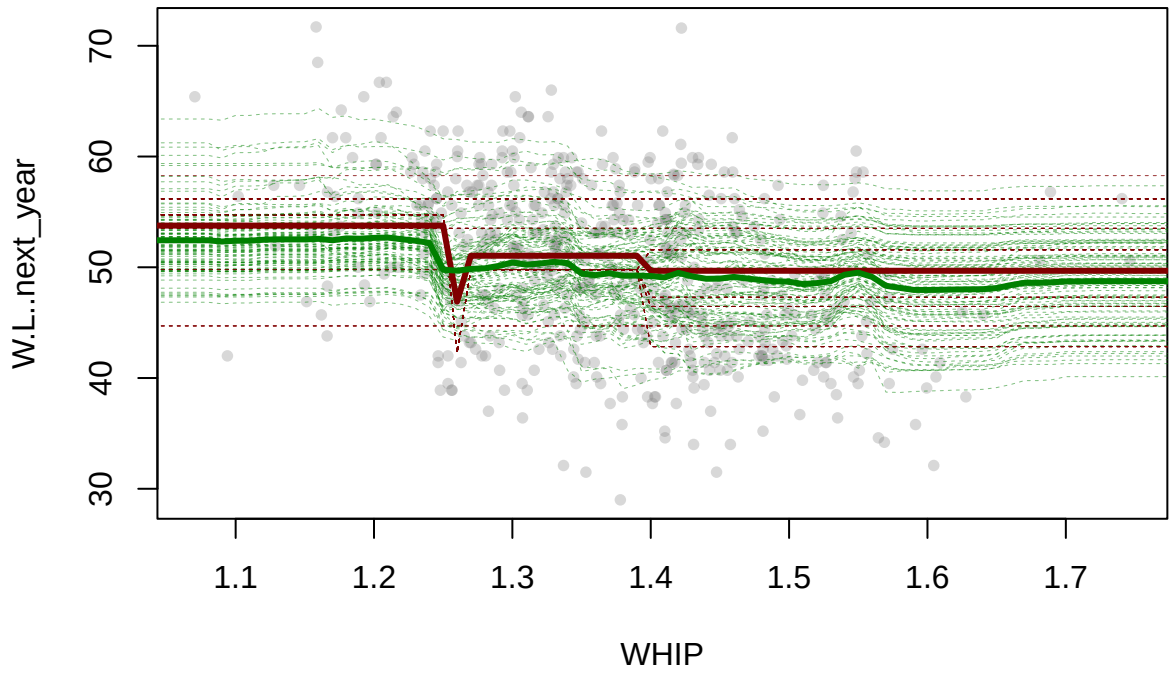
```
##      train     test
## 1 6.010486 8.204083
```

```
set.seed(139)
samp = sample(nrow(train.df),100)
dummy_df = train.df[samp,]
dummyx = seq(0,100,1)
plot(W.L..next_year~W.L..same_year, data=train.df,cex=0.8,pch=16,col=rgb(0.5,0.5,0.5,0.3))
yhats = matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
yhats.rf=matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
for(i in 1:nrow(dummy_df)){
  rows=dummy_df[rep(i,length(dummyx)),]
  rows$W.L..same_year=dummyx
  yhat = predict(tree4,new=rows)
  lines(yhat~dummyx,col=rgb(0.5,0,0,0.5),lwd=0.5,lty=2:3)
  yhats[i,]=yhat
  yhat.rf = predict(rf2,new=rows)
  lines(yhat.rf~dummyx,col=rgb(0,0.5,0,0.5),lwd=0.5,lty=2:3)
  yhats.rf[i,]=yhat.rf
}
mean_yhat = apply(yhats,2,mean)
mean_yhat.rf = apply(yhats.rf,2,mean)
lines(mean_yhat~dummyx,col=rgb(0.5,0,0,1),lwd=3)
lines(mean_yhat.rf~dummyx,col=rgb(0,0.5,0,1),lwd=3)
```



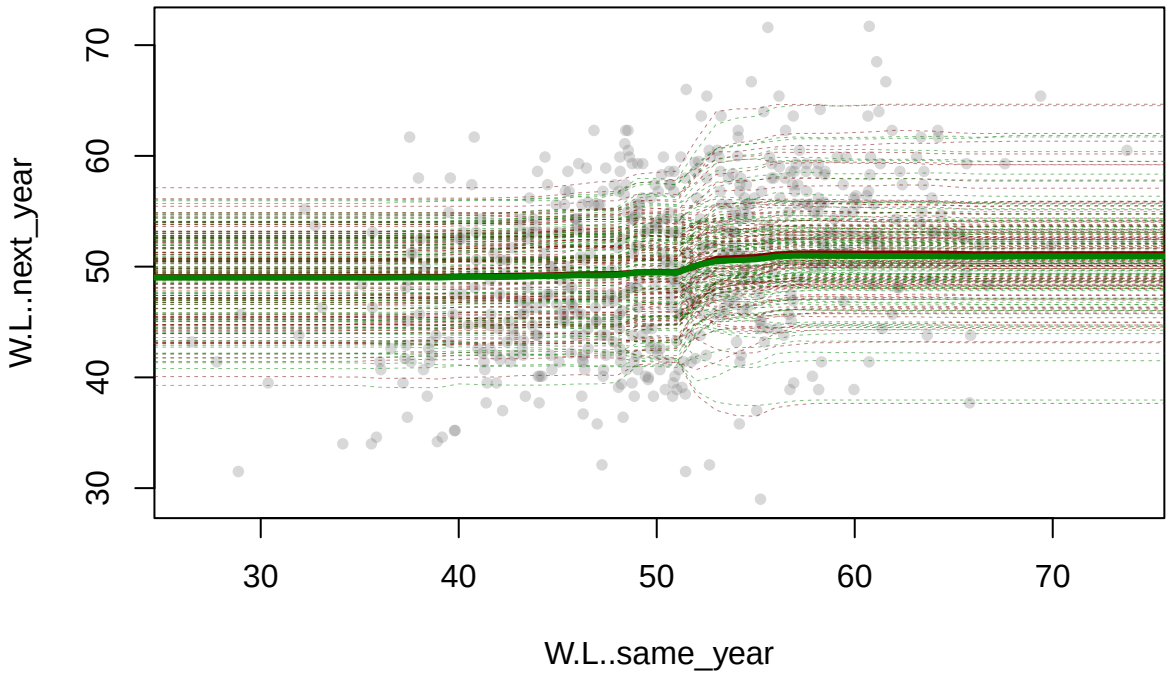

```
set.seed(139)
samp = sample(nrow(train.df),100)
dummy_df = train.df[samp,]
```

```
dummyx = seq(1,2,.01)
plot(W.L..next_year~WHIP, data=train.df,cex=0.8,pch=16,col=rgb(0.5,0.5,0.5,0.3))
yhats = matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
yhats.rf=matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
for(i in 1:nrow(dummy_df)){
  rows=dummy_df[rep(i,length(dummyx)),]
  rows$WHIP=dummyx
  yhat = predict(tree4,new=rows)
  lines(yhat~dummyx,col=rgb(0.5,0,0,0.5),lwd=0.5,lty=2:3)
  yhats[i,]=yhat
  yhat.rf = predict(rf2,new=rows)
  lines(yhat.rf~dummyx,col=rgb(0,0.5,0,0.5),lwd=0.5,lty=2:3)
  yhats.rf[i,]=yhat.rf
}
mean_yhat = apply(yhats,2,mean)
mean_yhat.rf = apply(yhats.rf,2,mean)
lines(mean_yhat~dummyx,col=rgb(0.5,0,0,1),lwd=3)
lines(mean_yhat.rf~dummyx,col=rgb(0,0.5,0,1),lwd=3)
```



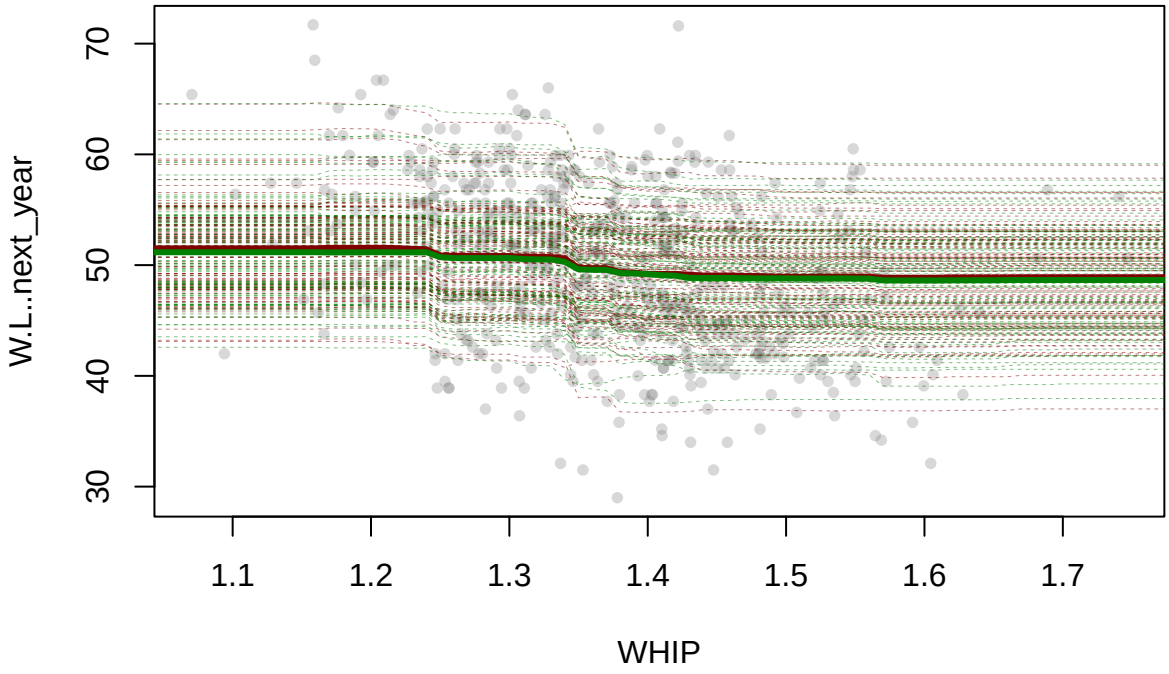

```
set.seed(139)
samp = sample(nrow(train.df),100)
dummy_df = train.df[samp,]
dummyx = seq(0,100,1)
plot(W.L..next_year~W.L..same_year, data=train.df,cex=0.8,pch=16,col=rgb(0.5,0.5,0.5,0.3))
yhats = matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
```

```
yhats.rf=matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
for(i in 1:nrow(dummy_df)){
  rows=dummy_df[rep(i,length(dummyx)),]
  rows$W.L..same_year=dummyx
  yhat = predict(bag,new=rows)
  lines(yhat~dummyx,col=rgb(0.5,0,0,0.5),lwd=0.5,lty=2:3)
  yhats[i,]=yhat
  yhat.rf = predict(rf1,new=rows)
  lines(yhat.rf~dummyx,col=rgb(0,0.5,0,0.5),lwd=0.5,lty=2:3)
  yhats.rf[i,]=yhat.rf
}
mean_yhat = apply(yhats,2,mean)
mean_yhat.rf = apply(yhats.rf,2,mean)
lines(mean_yhat~dummyx,col=rgb(0.5,0,0,1),lwd=3)
lines(mean_yhat.rf~dummyx,col=rgb(0,0.5,0,1),lwd=3)
```

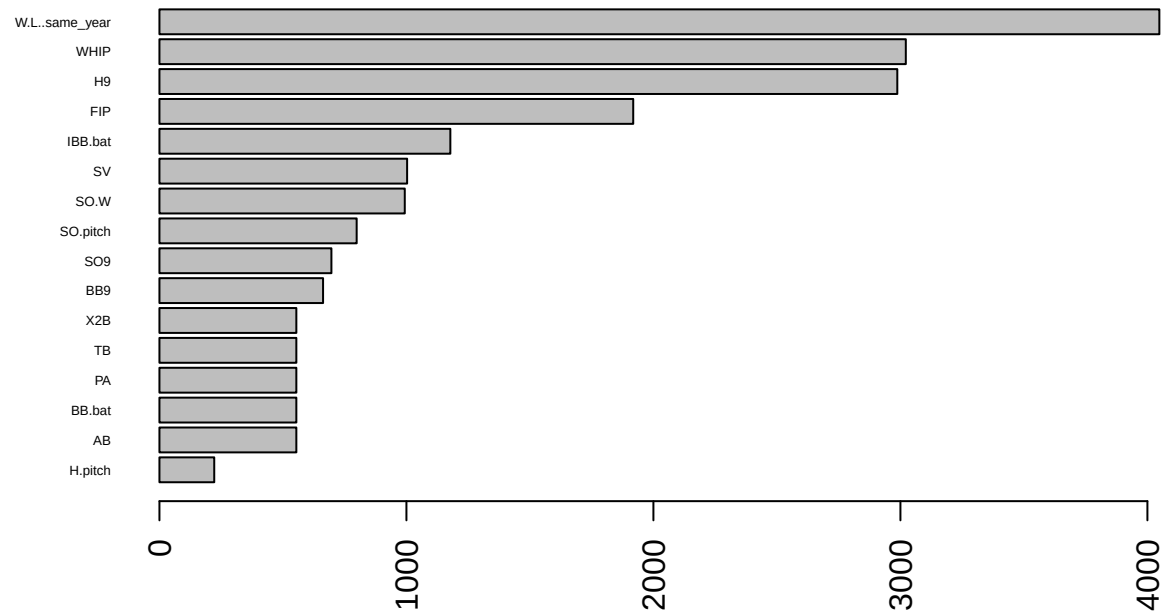



```
set.seed(139)
samp = sample(nrow(train.df),100)
dummy_df = train.df[samp,]
dummyx = seq(1,2,.01)
plot(W.L..next_year~WHIP, data=train.df,cex=0.8,pch=16,col=rgb(0.5,0.5,0.5,0.3))
yhats = matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
yhats.rf=matrix(NA,nrow=nrow(dummy_df),ncol=length(dummyx))
for(i in 1:nrow(dummy_df)){
  rows=dummy_df[rep(i,length(dummyx)),]
```

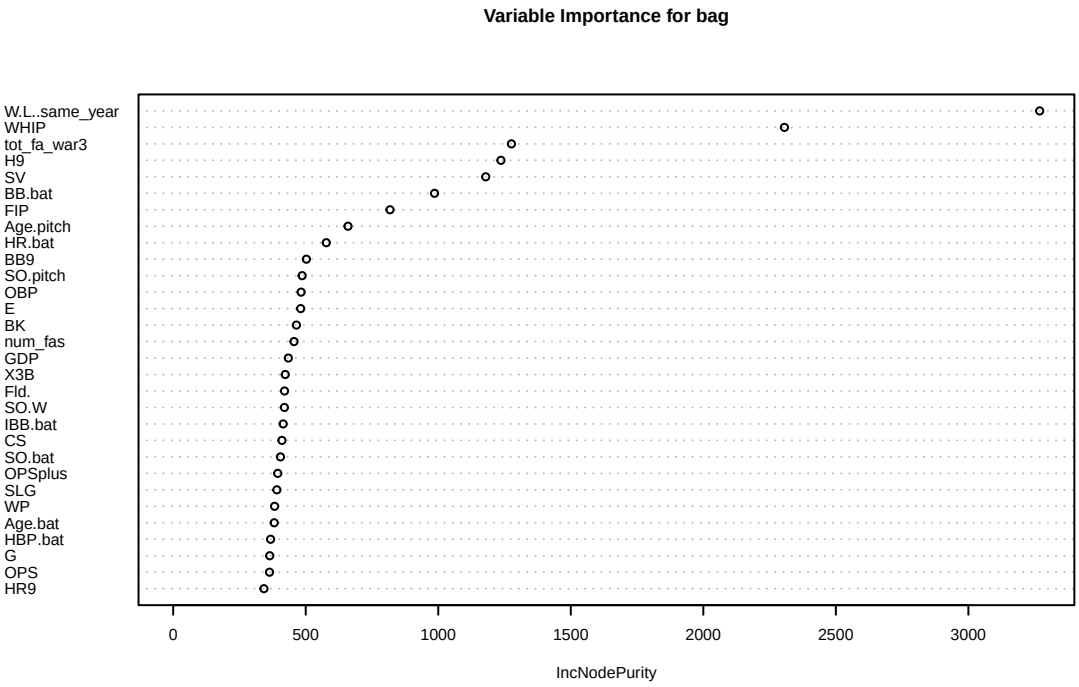
```
  rows$WHIP=dummyx
  yhat = predict(bag,new=rows)
  lines(yhat~dummyx,col=rgb(0.5,0,0,0.5),lwd=0.5,lty=2:3)
  yhats[i,]=yhat
  yhat.rf = predict(rf1,new=rows)
  lines(yhat.rf~dummyx,col=rgb(0,0.5,0,0.5),lwd=0.5,lty=2:3)
  yhats.rf[i,]=yhat.rf
}
mean_yhat = apply(yhats,2,mean)
mean_yhat.rf = apply(yhats.rf,2,mean)
lines(mean_yhat~dummyx,col=rgb(0.5,0,0,1),lwd=3)
lines(mean_yhat.rf~dummyx,col=rgb(0,0.5,0,1),lwd=3)
```



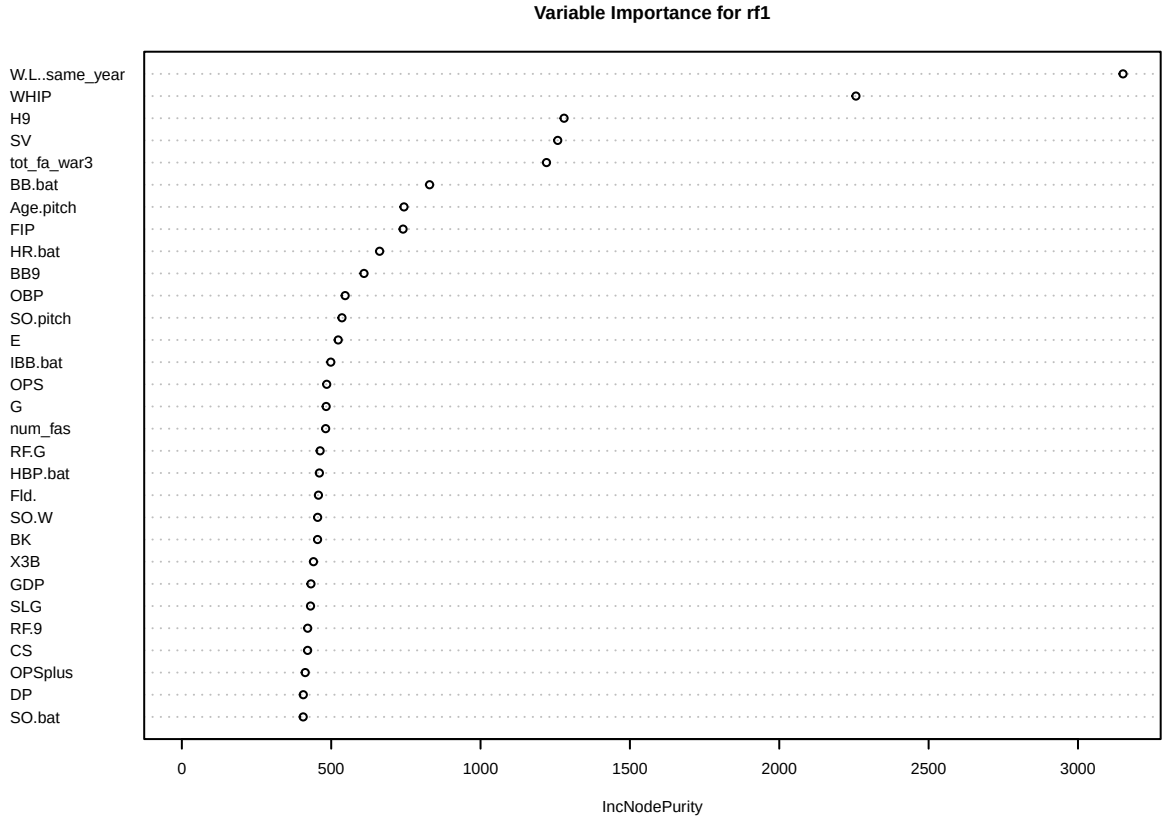

```
set.seed(139)
barplot(sort(tree2$variable.importance),horiz = T,las=2,cex.names = 0.4, main='Variable Importance for
```



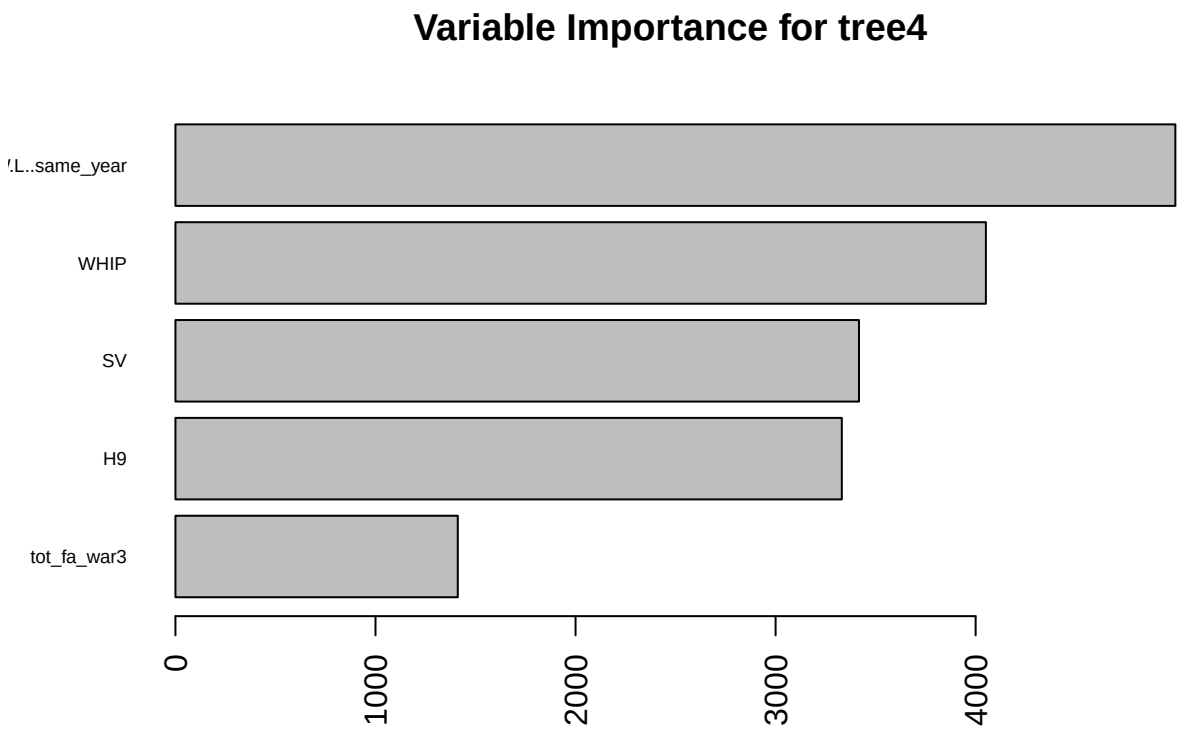

```
varImpPlot(bag, cex=0.5, main='Variable Importance for bag')
```



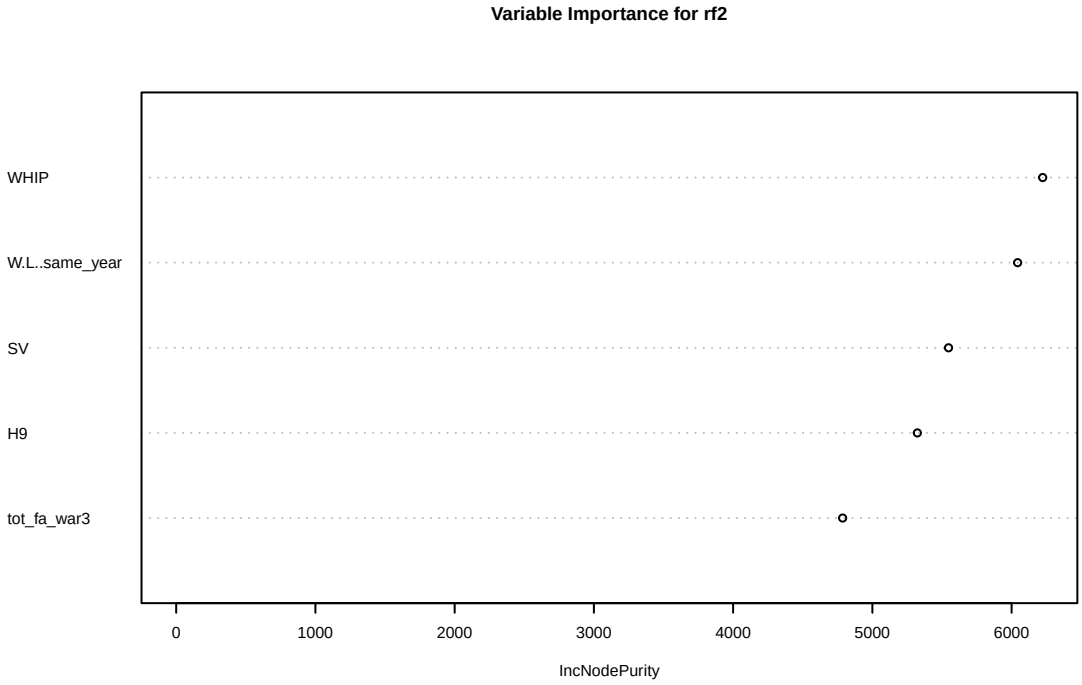

```
varImpPlot(rf1,cex=0.5, main='Variable Importance for rf1')
```




```
barplot(sort(tree4$variable.importance),horiz = T,las=2,cex.names = 0.6, main='Variable Importance for
```




```
varImpPlot(rf2, cex=0.5, main='Variable Importance for rf2')
```




```
set.seed(139)
tab <- matrix(c(RMSE.tree1.train, RMSE.tree1.test,
  RMSE.tree2.train, RMSE.tree2.test,
  RMSE.bag.train, RMSE.bag.test,
  RMSE.rf1.train, RMSE.rf1.test,
  RMSE.rf2.train, RMSE.rf2.test,
  RMSE.tree4.train, RMSE.tree4.test), nrow=6, byrow = TRUE
)
colnames(tab) <- c('train','test')
rownames(tab) <- c('tree1','tree2','bag', 'rf1', 'rf2', 'tree4')
tab <- as.table(tab)
tab
```

```
##          train     test
## tree1 3.951100 8.432410
## tree2 6.461346 7.490019
## bag   6.397272 7.109748
## rf1   6.377898 7.137898
## rf2   6.419483 7.680534
## tree4 6.010486 8.204083
```

Mixed Effects Model

```r
set.seed(139)
library(lme4)


# for (i in 1997:2022){
#   lmer_model <- lmer(team_data[[i]]$W.L.~poly(team_data[[i]]$BatAge, 2, raw = TRUE) + (1 + poly(team_
#   summary(lmer_model)
# }

lmer_model <- lmer(train.df$W.L..next_year ~ poly(train.df$Age.bat, 2, raw = FALSE) + (1 + poly(train.d
summary(lmer_model)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: train.df$W.L..next_year ~ poly(train.df$Age.bat, 2, raw = FALSE) +
##     ((1 | train.df$Tm) + (0 + poly(train.df$Age.bat, 2, raw = FALSE) |
##         train.df$Tm))
##
## REML criterion at convergence: 3574.3
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8353 -0.7280  0.0241  0.6893  3.3827
##
## Random effects:
##  Groups        Name                                      Variance Std.Dev. Corr
##  train.df.Tm   (Intercept)                                13.71    3.703
##  train.df.Tm.1 poly(train.df$Age.bat, 2, raw = FALSE)1 231.90   15.228
##                poly(train.df$Age.bat, 2, raw = FALSE)2 238.85   15.455   -1.00
##  Residual                                                42.18    6.495
## Number of obs: 536, groups:  train.df$Tm, 29
##
## Fixed effects:
##                                          Estimate Std. Error t value
## (Intercept)                               49.8660     0.7485  66.623
## poly(train.df$Age.bat, 2, raw = FALSE)1  -5.3344     8.0431  -0.663
## poly(train.df$Age.bat, 2, raw = FALSE)2   6.7511     7.9705   0.847
##
## Correlation of Fixed Effects:
##                   (Intr) p(.$A.,2,r=FALSE)1
## p(.$A.,2,r=FALSE)1 -0.009
## p(.$A.,2,r=FALSE)2  0.023 -0.132
```

```r
lmer_model <- lmer(train.df$W.L..next_year ~ poly(train.df$BA, 2, raw = FALSE) + (1 + poly(train.df$BA,
```

```
## boundary (singular) fit: see help('isSingular')
```

```r
summary(lmer_model)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: train.df$W.L..next_year ~ poly(train.df$BA, 2, raw = FALSE) +
##     ((1 | train.df$Tm) + (0 + poly(train.df$BA, 2, raw = FALSE) |
```

```
##         train.df$Tm))
##
## REML criterion at convergence: 3562.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8878 -0.6824  0.0135  0.6932  3.2131
##
## Random effects:
##  Groups        Name                                Variance  Std.Dev. Corr
##  train.df.Tm   (Intercept)                         13.870992 3.72438
##  train.df.Tm.1 poly(train.df$BA, 2, raw = FALSE)1  1.522582 1.23393
##                poly(train.df$BA, 2, raw = FALSE)2  0.004076 0.06384  1.00
##  Residual                                          41.796196 6.46500
## Number of obs: 536, groups:  train.df$Tm, 29
##
## Fixed effects:
##                                    Estimate Std. Error t value
## (Intercept)                         49.9374     0.7497  66.612
## poly(train.df$BA, 2, raw = FALSE)1  33.4075     8.7293   3.827
## poly(train.df$BA, 2, raw = FALSE)2   3.5883     6.8383   0.525
##
## Correlation of Fixed Effects:
##                     (Intr) p(.$BA,2,r=FALSE)1
## p(.$BA,2,r=FALSE)1 0.018
## p(.$BA,2,r=FALSE)2 0.005  0.027
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
# lmer_model <- lmer(W.L..next_year ~ Age.bat + PA + AB + H.bat + X2B + X3B +
                # HR.bat + SB + CS + BB.bat + SO.bat + BA + OBP + SLG + OPS + OPSplus +
                # TB + GDP + HBP.bat + SH + SF + IBB.bat + Age.pitch + W.L..same_year +
                # GF + SHO + SV + IP + H.pitch + HR.pitch +
                # BB.pitch + IBB.pitch + SO.pitch + HBP.pitch + BK + WP + BF +
                # FIP + WHIP + H9 + HR9 + BB9 + SO9 + SO.W +
                # G + Inn + Ch + PO + A + E + DP + Fld. +
                # RF.9 + RF.G + tot_fa_war3 + num_fas || Tm, data = train.df, verbose=TRUE)
```

```
set.seed(139)
summary(lmer_model)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: train.df$W.L..next_year ~ poly(train.df$BA, 2, raw = FALSE) +
##     ((1 | train.df$Tm) + (0 + poly(train.df$BA, 2, raw = FALSE) |
##         train.df$Tm))
##
## REML criterion at convergence: 3562.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8878 -0.6824  0.0135  0.6932  3.2131
##
## Random effects:
```

```
##  Groups        Name                                Variance  Std.Dev. Corr
##  train.df.Tm   (Intercept)                         13.870992 3.72438
##  train.df.Tm.1 poly(train.df$BA, 2, raw = FALSE)1  1.522582 1.23393
##                poly(train.df$BA, 2, raw = FALSE)2  0.004076 0.06384  1.00
##  Residual                                          41.796196 6.46500
## Number of obs: 536, groups:  train.df$Tm, 29
##
## Fixed effects:
##                                   Estimate Std. Error t value
## (Intercept)                        49.9374     0.7497  66.612
## poly(train.df$BA, 2, raw = FALSE)1  33.4075     8.7293   3.827
## poly(train.df$BA, 2, raw = FALSE)2   3.5883     6.8383   0.525
##
## Correlation of Fixed Effects:
##                     (Intr) p(.$BA,2,r=FALSE)1
## p(.$BA,2,r=FALSE)1 0.018
## p(.$BA,2,r=FALSE)2 0.005  0.027
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch + (1 + WHIP + W.L..same_year +
```

```
## boundary (singular) fit: see help('isSingular')
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.007809
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.051978
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch | Tm, data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.860842
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.997159
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch + tot_fa_war3 | Tm, data = tra
```

```
## boundary (singular) fit: see help('isSingular')
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.839756
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.029939
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch + H9 | Tm, data = train.df)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.631575
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.984588
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ WHIP + W.L..same_year + Age.pitch + H9 + (1 + WHIP + W.L..same_y
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.396988 (tol = 0.002, component 1)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model is nearly unide
##  - Rescale variables?;Model is nearly unidentifiable: large eigenvalue ratio
##  - Rescale variables?
```

```
# summary(lmer.varmodel)
# predict(lmer.varmodel)
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.687929
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.944894
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ Age.bat + PA + AB | Tm, data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.957596
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.091514
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ Age.bat + PA + AB + (1 + Age.bat + PA + AB | Tm) , data = train.
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.946579
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.091969
```

RIDGE full

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + Fld. + BA + WHIP + SLG + (1 + OBP + Fld. + BA + WHIP + SLG
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.618222
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.872338
```

OBS SLG WHIP BA Fld.

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + SLG + OPS + SHO + Fld. + (1 + OBP + SLG + OPS + SHO + Fld.
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 3 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.721457
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.192263
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + Fld. + BA | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.174103
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.367717
```

RIDGE full interaction

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ Fld. + OBP:Fld. + BA:OBP + (1 + Fld. + OBP:Fld. + BA:OBP | Tm) ,
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.051227
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.063994
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ Fld. + OBP:Fld. + BA:OBP | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0084969 (tol = 0.002, component 1)
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.004799
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.280714
```

LASSO full

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + WHIP + Fld. + (1 + OBP + WHIP + Fld. | Tm) , data = train.
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.686619
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.914397
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ OBP + WHIP + Fld. | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00991342 (tol = 0.002, component 1)
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.491354
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.820872
```

LASSO full interaction

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ SHO:IBB.pitch + OBP:Age.pitch + BK:HR9 + (1 + SHO:IBB.pitch + OBP
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.0158508 (tol = 0.002, component 1)
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.187858
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 6.815641
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ SHO:IBB.pitch + OBP:Age.pitch + BK:HR9 | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient

## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 6.082858
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.089855
```

Random Forest 1 and Random Forest 2

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + Age.pitch | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.763283
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.052558
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + Age.pitch + (1 + W.L..same_year + WHIP +
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.89997
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.046541
```

Prunded Decision tree with 3 Predictors

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + Age.pitch | Tm , data = train.df)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## unable to evaluate scaled gradient
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge: degenerate Hessian with 1 negative eigenvalues
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.763283
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.052558
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + Age.pitch + (1 + W.L..same_year + WHIP +
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.89997
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.046541
```

Pruned Decision tree with all predictors

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + H9 | Tm , data = train.df)
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.659651
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.056473
```

```
set.seed(139)
lmer.varmodel <- lmer(W.L..next_year ~ W.L..same_year + WHIP + H9 + (1 + W.L..same_year + WHIP + H9 | Tr
```

```
## boundary (singular) fit: see help('isSingular')
```

```
RMSE(train.df$W.L..next_year, predict(lmer.varmodel))
```

```
## [1] 5.718808
```

```
RMSE(test.df$W.L..next_year, predict(lmer.varmodel, newdata=test.df))
```

```
## [1] 7.07585
```

Testing stuff